THE NEW CLIMATE ECONOMY
The Global Commission on the Economy and Climate

Working Paper

Better Growth, Better Cities: Rethinking and Redirecting Urbanisation in Africa

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Executive summary

The African continent is undergoing an unprecedented phase of urbanisation. How to ensure safe, productive and healthy lives for the 22 million people that are added to Africa's cities every year, and the estimated 1.34 billion people that will live in African cities in 2050, is a question of crucial importance to Africa's future economic and social development. It is a question that will have to be addressed in the midst of unprecedented climate instability.

Low per capita CO_2 emissions, low levels of car ownership and the lack of urban infrastructure in African cities are a symptom of under-development and low household incomes. However, in the context of climate change the fact that so much of Africa's cities are yet to be built and serviced, presents a significant opportunity for Africa to become a major leader in low-carbon urban development. The appeal to policy makers of low-carbon energy services, public transport, off-grid sanitation and compact urban forms for African cities is in their ability to deliver critical services to growing urban populations and support wider economic prosperity in spite of the relative lack of governance and adequate public sector budgets.

This report documents a wide range of projects, programmes and plans currently being pursued by African cities as part of a new mode of low-carbon urbanism that is simultaneously helping to realise virtuous cycles of local economic development and social inclusion, as well as climate risk reduction. The emerging evidence shows that some African cities are using the global response to climate change as an opportunity to convert their historical under-development into new economic competitiveness.

The institutional requirements for unlocking this potential differ from city-to-city and will involve varying combinations of national government, local authorities and community-based entrepreneurs to ensure successful implementation. The forging and strengthening of these institutional hybrids represents a central challenge for the continent's development community.

About this working paper

This paper was prepared as an input to the 2015 Africa Progress Report *'Power, People, Planet: Seizing Africa's energy and climate opportunities'* produced by the Africa Progress Panel led by Mr. Kofi Annan which can be found at: www.africaprogresspanel.org.

The Africa Progress Report (APR) is the annual flagship publication of the Africa Progress Panel. The APR draws on the best research and analysis available on Africa and compiles it in a refreshing and balanced manner. The Panel makes policy recommendations for African political leaders and civil society who collectively have the primary responsibility for spurring Africa's progress. In light of the continent's dynamic links with the rest of the world, the APR also highlights critical steps that must be taken by leaders in the international public and private sector.

The findings and conclusions in the paper are those of the author and do not necessarily reflect the positions or policies of the African Centre for Cities, Africa Progress Panel and New Climate Economy.

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1. The urban challenge and opportunity

In Africa the potential to sustain economic growth is contingent upon safe and productive livelihood opportunities for the 22 million people that are added to the urban population annually. The common assumption is that climate change will compound this challenge (World Bank, 2010; IPCC, 2014; Moore and Diaz, 2015) but that need not be the case. As ever on the African continent – a continent spanning 70 degrees of latitude, comprising 54 sovereign countries and with over 1,500 recognised languages – the lived reality of urban development is more diverse and more interesting than is captured in any single narrative or single trajectory. There are examples in which urbanisation and climate change have created new opportunities.

Africa has contributed less than 4 per cent to the build-up of atmospheric greenhouse gases, and most of the continent's leaders feel little obligation to sacrifice development in support of international mitigation or the 2°C warming target (Frame et al., 2014). There is, however, growing interest in low-carbon and climate adaptive development for its ability to offer cities a more suitable model of service delivery and economic growth; a model that has remained elusive in the post-independence pursuit of prosperity (LSE Cities, 2012; Swilling and Annecke, 2012; UN-Habitat, 2014).

Prosperous, socially-inclusive, compact cities, serviced by public transport, potable water and clean energy are not the norm or default in Africa. Ironically, however, the relative lack of infrastructure and services create the opportunity to avoid lock-in to fossil fuels, and to create from scratch the infrastructure and institutional capacity to respond effectively and systematically to climate-change risks.

As a contribution to the work of the New Climate Economy, and as an input to the *Africa Progress Report 2015*, this paper set out to compile evidence on how to support better growth for a better climate through better African cities. A feature of much of the literature on African cities to date is that it anticipates change, describes plans and highlights potential, but provides very little by way of proven success (AU, 2014; UN-Habitat, 2014; UNEP, 2015). This would provide cause for concern if it were not for the unprecedented rate, scale and nature of Africa's ongoing urbanisation. The rate of urbanisation will ensure the transformation of Africa's cities in the next three decades, and makes the present state of these cities a poor proxy for what might ensue. The nature of this transformation is open to influence, and holds profound implications for the continent's economic prospects and the global effort to prevent runaway climate change.

Regional differences (most notably between North Africa and the rest of the continent) ensure that there is no generic solution to the continent's urban challenges. There are, however, a number of initiatives that are using the opportunities created by the global effort to address climate change to address local development challenges.

This report draws on the emerging evidence to explore how the simultaneous climate and urban challenges might catalyse an alternative, more appropriate, agenda for development in African cities. The report findings support three complementary propositions:

- **What:** Low-carbon, climate adaptive urban development avoids significant costs and offers the most viable means of harnessing Africa's current urbanisation in the short term. It also provides long-term benefits for the economy, for local resource flows and for the viability of international efforts to prevent runaway climate change (New, 2014).
- **Why:** Adaptive, low-carbon urban development, supported by new technologies, is able to deliver urban services in spite of fiscal and governance deficits across Africa. This mode of urban development is able to attract new investment, create new work opportunities, foster local resilience and retain access to international markets, while offering new opportunities for "place making" in Africa's cities (Behrens and Watson, 1996).
- **How:** In the context of urban informality and contested local governments in Africa, the urban development described in this report is contingent upon the accelerated assimilation of new technologies and hybrids of national and local government, community-based entrepreneurs and the private sector.

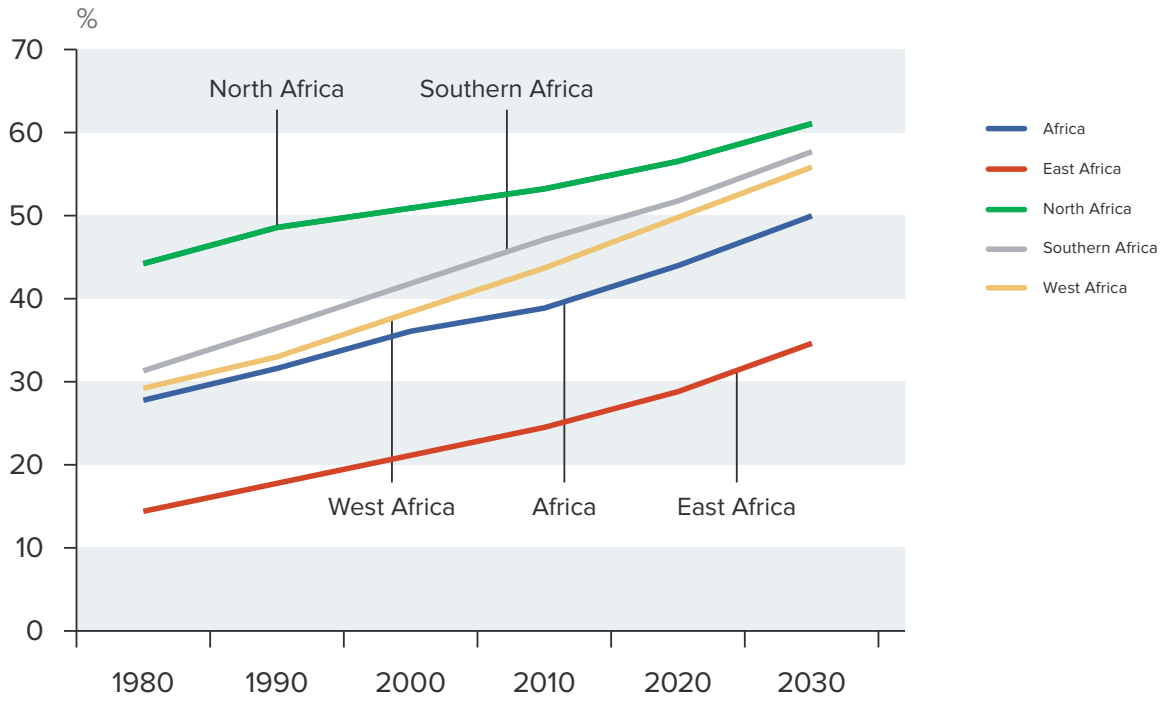
In this sense, low-carbon, climate adaptive cities might be the means to deliver "The Africa We Want" as outlined in the African Union's *Agenda 2063*. More specifically, cities built in anticipation of climate change could be the best means of delivering on the African Union's urban vision of "... hubs of cultural and economic activities, with modernized infrastructure, [where] people have access to all the basic necessities of life including shelter, water, sanitation, energy, public transport and ICT". (AU, 2014, p.3). This idea is explored in the following sections of this report:

- Section 2 provides a description of Africa's ongoing urbanisation. It draws attention to the unprecedented nature of African urbanisation in terms of scale, pace, socio-economic profile and local governance capacity. In so doing it questions the potential for a conventional urban dividend and the utility of traditional planning and development instruments. Instead it describes the institutional, technological and economic influences that are likely to shape African cities.
- Section 3 describes the default climate change implications for Africa's cities in terms of both emissions and biophysical impacts, and the implications of climate change for urban development.
- Section 4 highlights the potential for climate change to catalyse new modes of urban development in Africa. The section draws on case-study examples under the themes of transport, energy, waste, water and sanitation, spatial form and human settlements.
- Section 5 contrasts the economic and wider costs of "urbanisation as usual" with the benefits of a proactive approach to adaptation and urbanisation, drawing on the case-study examples from Section 4.
- Section 6 identifies the prerequisites for scaling successful initiatives with particular emphasis on institutional hybrids, finance and political requirements.
- Section 7 concludes with implications for policy makers.

2. Africa's urban revolution – dividends or deficits?

Africa's urban population is expected to triple between 2011 and 2050 (from 471 million to 1.34 billion) and more than half the continent's inhabitants will reside in cities by 2035 (UN-Habitat, 2014). By 2050 Africa's urban population is expected to comprise 21 per cent of the world's urban population.

Figure 1
Percentage urbanisation by region in Africa 1980–2030



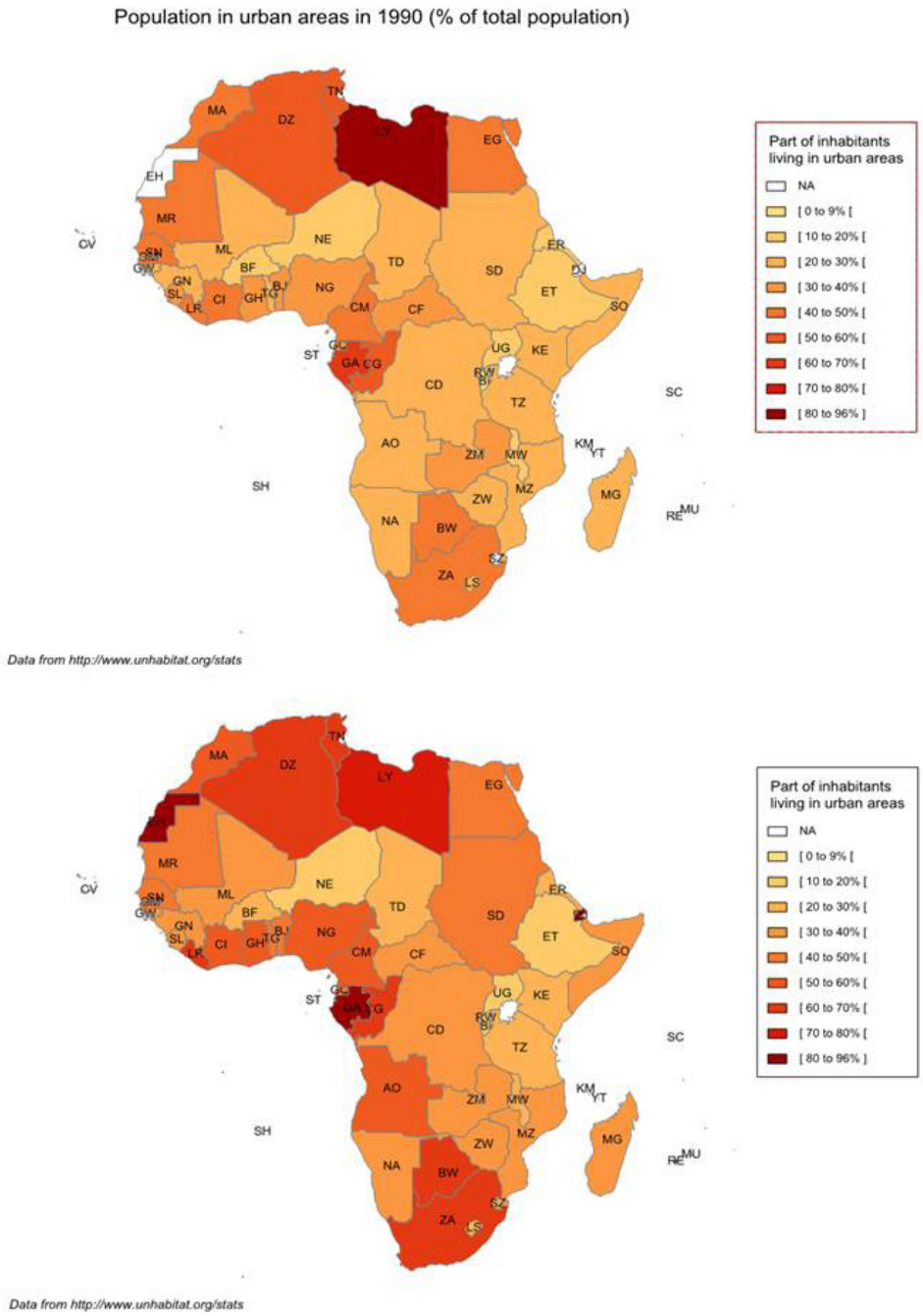
Source: World Bank, 2014

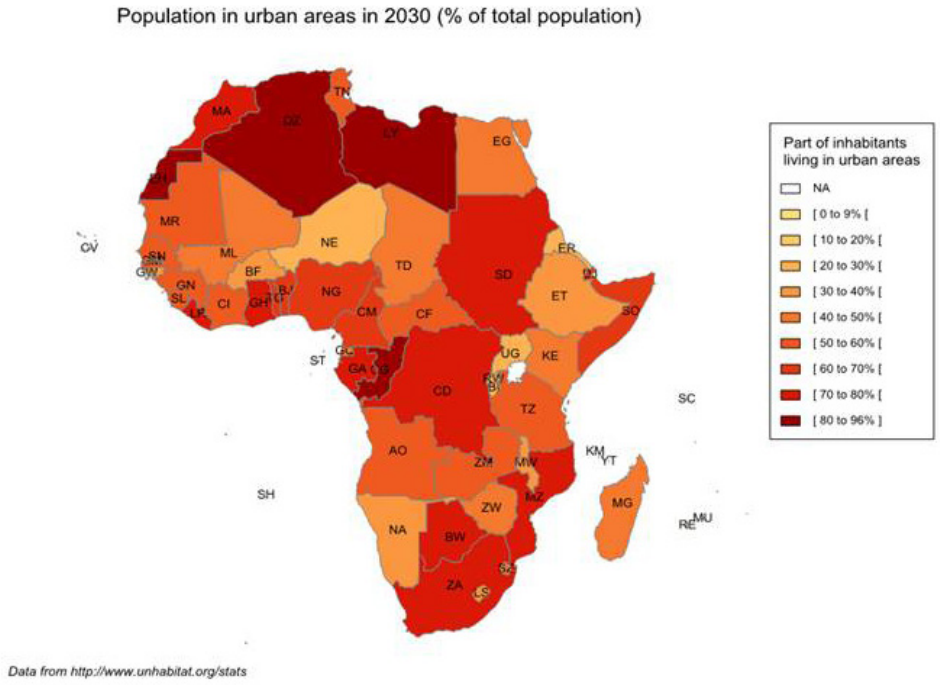
The mega-cities of West and Central Africa, together with Cairo in the north, will be the largest, although East African cities are expected to experience the highest rate of growth (World Bank, 2014). The number of people that will be added to Africa's cities in the next forty years (1 billion) is an order of magnitude greater than in Europe and North America's urbanisation phase, and Africa's urbanisation will take place in less than half the time taken in those regions (UN DESA, 2014).

No country has ever achieved middle-income status without a growing urban population. "Urban dividend" is the term used to describe the economic benefits that arise from an alignment of talented job-seekers, livelihood opportunities and services in cities (Pieterse, 2013). This alignment has been a feature of economic growth in OECD and Asian countries, where differences in rural–urban productivity saw urbanisation generate productivity gains and economic growth (Spence et al., 2009).

Figure 2

Progressive urbanisation on the African continent (1990–2030)



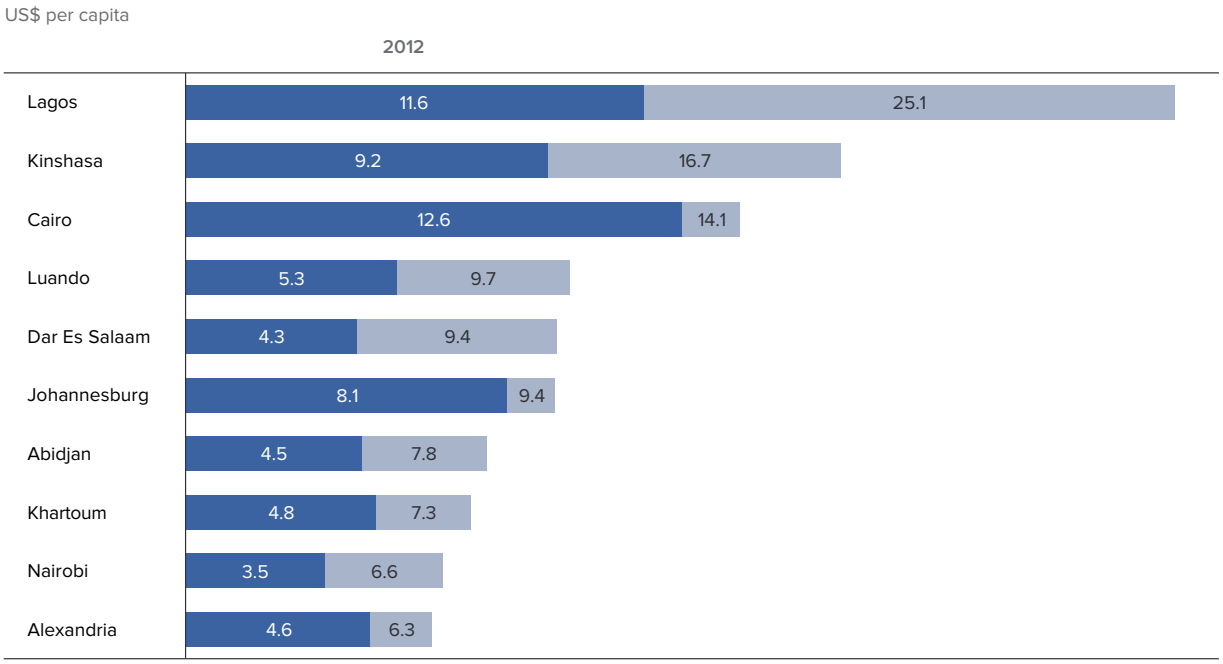


Source: UN-Habitat. Image created by Pauline Sabatini.

Africa's rapid urbanisation has been accompanies by economic growth. Between 2000 and 2013, while the global economy stagnated, Africa's GDP growth averaged 5.1 per cent. In 2012 the continent boasted 11 of the 20 fastest-growing economies in the world (World Bank, 2012). A study by New Climate Economy of 69 cities in 35 Sub-Saharan countries anticipated these cities to grow at over 5 per cent per annum between 2012 and 2030, adding $1 trillion to their collective GDP (Godfrey and Zhao, 2014) and expanding the urban middle-class in many African countries. Urban Africans also enjoy better access to "improved water" and reticulated sanitation (83 per cent compared to 53 per cent) and electricity (67.9 per cent compared to 14.1 per cent) than their rural counterparts (World Bank, 2012). The trends raise the spectre of African cities drawing on new service delivery technologies and infrastructure to "leap-frog" onto low-carbon development trajectories complete with new competitiveness in emerging green economy sectors (Beinhocker et al., 2008; Aghion et al., 2014; The Economist, 2014). It is a compelling prospect for the continent that has long served as the emblem of obdurate poverty and humanitarian crises.[1]

Figure 3

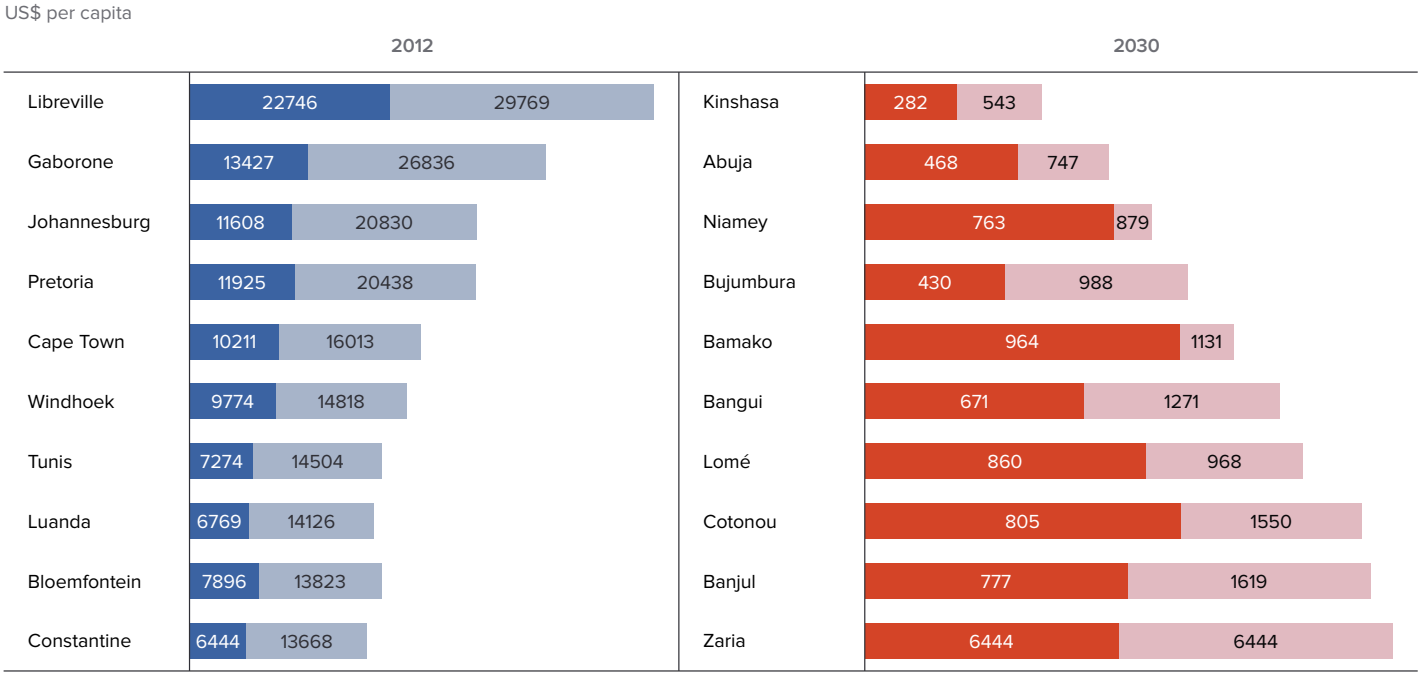
Africa's most populous cities (2012 and 2030)



Source: Godfrey and Zhao, 2014, for NCE drawing on data from Oxford Economics and LSE Cities.

Figure 4

Africa's richest and poorest cities (2012 and 2030) in $ per capita



Source: Godfrey and Zhao, 2014, for NCE drawing on data from Oxford Economics and LSE Cities.

There is, however, a counter-perspective that is more circumspect. Proponents of this view do not deny the potential for an urban dividend, but emphasise the underlying socio-economic, demographic and institutional conditions that frustrate the emergence of this virtuous cycle in African cities (Parnell and Pieterse, 2014; Watson, 2014). More specifically, while commodity-driven economic growth has been supported by moderate increases in trade, investment in telecoms and an expansion of the middle class,[2] the benefits have been unevenly distributed. Per capita income in Ethiopia is just $800 per annum, while in Botswana it is $12,000. This disparity is replicated within countries and within cities. In the recent summary of Millennium Development Goals progress, sub-Saharan Africa's relative lack of progress towards "eradicating extreme poverty" and "reducing infant mortality" remains conspicuous (UN-Habitat, 2014). Fifty per cent of Africans continue to live on less than $1.25 per day and only 4 per cent live on more than $10 per day (World Bank, 2014). As a result, the tax base and purchasing power in African cities remain low and African cities remain chronically under-serviced by infrastructure (Benerjee and Morella, 2011).

Addressing the infrastructure backlog would require $68 billion to $93 billion per annum over the next three decades, a third of which would be for maintenance (AfDB, 2011). This is not money that Africa's local authorities can easily raise (see Table 2). Nationally collected commodity revenue is sparingly allocated to address urban priorities,[3] especially where cities are the locus of political opposition. The fiscal challenge is compounded by the number (almost half) of urban Africans that are anticipated to live in cities smaller than 300,000 people by 2050, cities that will be too small (and too poor) to create market agglomeration effects and economies of scale in the provision of infrastructure (UN-DESA, 2014).

Table 1

Africa's relative development indicators

	Sub-Saharan Africa	North Africa (and Middle East)	OECD	World
People per km²	39	40	37	55
% urban	37	60	80	53
CO_2 per capita	0.8	3.9	10.0	4.9
Life expectancy at birth	56	71	80	71
Primary education attainment (% of relevant age)	70	95	99	92
Urban access to electricity (%)	68	99	100	95
Car ownership (%)	5	9	56	17
Internet users (per 100 people)	17	34	75	38

Source: World Bank (North Africa includes the Middle East in World Bank data)

Further undermining the prospects for Africa's urban dividend is the growing amount of money owed to private creditors, with some countries' debt set to exceed GDP in 2015 as commodity prices drop (*The Economist*, 2014).

Perhaps most critically, political and fiscal power on the continent continues to reside with national governments, and African cities have a limited ability to influence their prospects. Africa's growing number of urban residents live under weak, often highly contested governance arrangements with a limited capacity to apply the urban planning instruments conventionally used to gather revenue, determine urban form, influence consumption patterns, deliver services and ensure safety, all of which are necessary to ensure an urban dividend (Owusu and Agye-Mensah, 2011; UN-Habitat, 2014; Jaglin, 2014).

Under current trajectories, then, urbanisation will see informality emerge as the definitive feature of life for urban Africans. Already 61 per cent of urban Africans live in informal settlements and 60 per cent engage in informal work that precludes mortgage finance or progressive livelihood strategies (World Bank, 2014).

Table 2

Total local government spend ($/person/year) for select African cities using 2007–2009 data[4]

	Population (mill)	Local fiscal capacity ($ per person per year)
Dakar	2.8	22.4
Addis Ababa	2.8	91.0
Accra	2.1	12.5
Kampala	1.4	29.2
Kigali	0.8	39.8
Dar es Salaam	2.9	29.4
Johannesburg	3.9	702.0
Cape Town	3.7	727.3
Maputo	1.1	43.8

Source: Stren, 2012; ODI, 2012; own calculations

Much of the recent growth in infrastructure and economic activity that has taken place has been financed by the private sector. This investment is necessary and it may be premature to suggest that it is a problem. The reality, though, is that it is taking place without the attenuating influence of a coherent taxation, tenure or planning system and is being fashioned around the spatial and service delivery needs of multi-national companies and the urban middle class (Parnell and Pieterse, 2014; Watson, 2014). The result is a series of paradoxes: slum settlements are expanding adjacent to "modern" gated communities and shopping malls;[5] inter-city freeways connect congested and poorly maintained inner-city streets; mega-scale power plants are being planned but low levels of grid connectivity persist and high energy prices truncates access for those that have been connected; large dams (often coupled with hydroelectric power schemes) are impounding water but 600 million urban Africans in sub-Saharan Africa do not have access to reticulated water (World Bank, 2012). The current contribution of private-sector investment is superficially modernising urban systems that are fractured, divisive and pre-disposed to long-term failure. Cities that expand on this template will struggle in three critical ways:

- Socially, through exclusion, the transfer of environmental and economic risk to the uninsured and ongoing conflict and crime;
- Environmentally, through water pollution, air pollution, repeated flooding and lock-in to carbon intensity; and
- Economically, due to their exposure to biophysical risk, high levels of unemployment, unaffordable maintenance costs for poorly functioning infrastructure, the inability of public services to catalyse higher earnings and shared economic growth, and restricted access to import markets that favour low-carbon products.

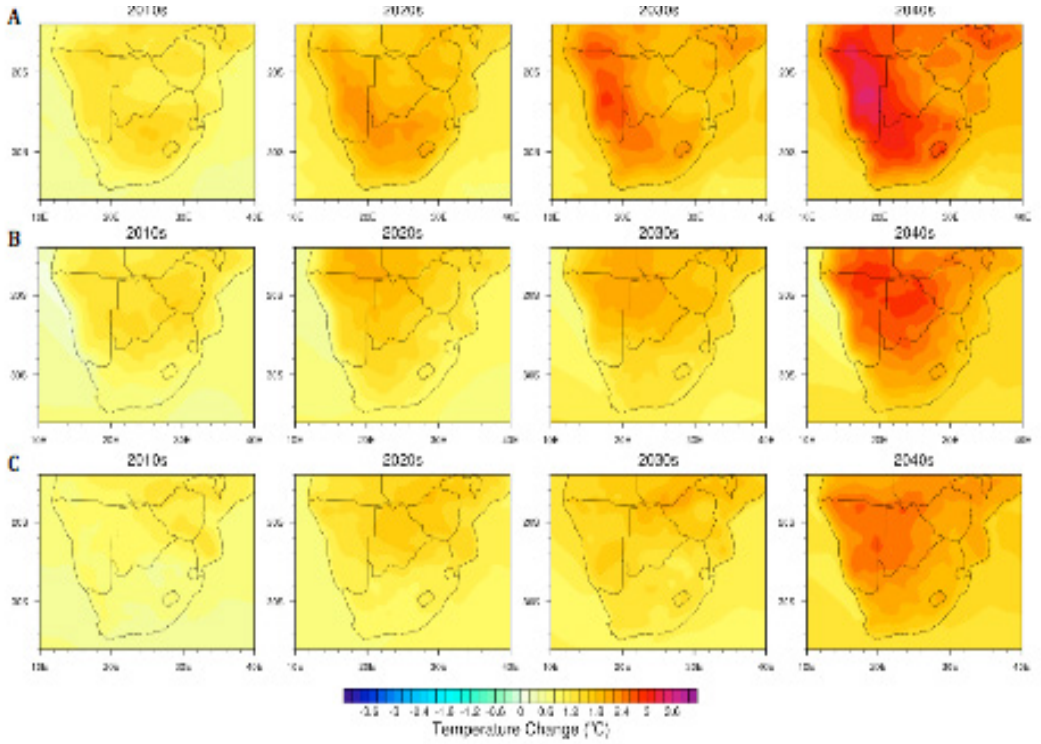
3. Climate change and African cities

The structural impediments to realising an urban dividend in Africa would exist in the absence of anthropogenic climate change. Climate change will, however, bring the urban development deficit into sharper contrast. In doing so, it could also provide the convening force and technological rationale for a new mode of service delivery in African cities – one that is capable of addressing the current impediments and delivering a new urban growth model complete with long-term competitiveness and improved wellbeing.

Africa accounts for less than 2 per cent of current greenhouse gas (GHG) emissions and the continent's contribution to the concentration of GHGs in the atmosphere is 4 per cent (Baumert et al., 2005).[6] In spite of this, much of the continent is already warming more quickly than the rest of the world. By 2050 mean atmospheric temperatures in Africa will almost certainly be at least 2°C above the long-term average (IPCC, 2014). Botswana is already 1.2–1.8°C warmer than it was in 1960 (Daron, 2014).

As the result of climate change, Africa's urban development is likely to confront unprecedented biophysical risks, more exacting environmental policies on global trade and investment, and limited recourse to the cheap liquid fuel and coal-fired electricity that underpinned urbanisation in OECD countries.

Figure 5
Projected warming under three different climate scenarios in sub-Saharan Africa



Source: Daron, 2014, where the different scenarios are based on different climate-change projections.

There are claims that the continent's history of coping with change prepares it for effective adaptation and resilience. The more pervasive view is that climate-change risk, like other environmental risks, is regressive and will expose institutional deficits, increase vulnerability and deepen poverty traps (Hallegatte, 2007; Tol, 2011; Samson et al., 2011; IPCC, 2014[7]).

Perturbed climates, the result of a 0.85°C mean global temperature rise, are already adversely affecting the availability of food and water and changing the prevalence of disease in Africa. Adapting to these changes will, by some estimates, cost the continent $7–15 billion between 2015 and 2020 and as much as $50 billion per annum by 2050 if mean global temperatures rise by 2°C (UNEP, 2015b). A 2012 UNICEF report claimed that 99 per cent of deaths attributed to climate change had occurred in developing countries and that 80 per cent of those were children, highlighting the disproportionate burden of climate-change risk carried by Africa. It is, however, climate change's ability to truncate energy options and expose governance and infrastructure deficits that, unless addressed, will prove most challenging (Douglas et al., 2008; Tol, 2011). This more insidious and systemic climate-change impact is also more difficult to counter. For example:

- In Kampala, near-surface temperature increased between 1979 and 2005, making localised rainfall both more intense and more variable (Rautenbach, 2014). This has increased the prevalence of flooding in the city (UN-Habitat, 2014; Sliuzas et al., 2013) and, in conjunction with longer dry periods, disrupted the generation of hydroelectric power and the distribution of electricity. Lagos, Windhoek and Kinshasa have all had similar experiences in which the lack of grid integration has been exposed by rising urban demand and increasingly variable runoff to hydroelectric plants.
- More frequent and more intense natural disasters will expose the absence of cadastral systems and census data, frustrating the mobilisation of relief efforts and drawing conflicts over boundaries and the allocation of resources. This was the case in Maputo following the 2000 floods and is periodically reported in the slums of Nairobi and Blantyre following flooding (Parnell, 2015).

- Poor coastal planning and injudiciously reclaimed land in the deltas of Lagos, Dakar and Alexandria will be exposed by sea-level rise. Emergency interventions and the replacement of public infrastructure that has been located too near the coast will divert funding due for other programmes (Dasgupta et al., 2007). In Cape Town, in which parts of the city are built on reclaimed land, the cost of sea-level rise has been estimated at $49 million – $2.01 billion by 2035, depending on the extent of the rise (Brundrit and Cartwright, 2012).
- Natural disasters will induce knee-jerk reactions and see a plethora of sea-walls, new dams, desalination projects and centrally co-ordinated food-relief programmes. These projects will divert budgets and some will inadvertently increase risk and disrupt livelihood strategies by undermining the flow of services from local ecosystems (UN-Habitat, 2012b).
- Shifting disease vectors will add to the existing burden of disease and increase dependency on the healthy, working urban population while exposing inadequate public health-care facilities.
- Livestock losses will accelerate migration to urban centres for resource-poor farmers and further inundate urban service delivery, compounding infrastructure and service-delivery backlogs and fuelling ethnic conflicts.
- Global concern around climate change will place increasing scrutiny on hydro-carbon companies looking to extract Africa's coal and oil resources. More generally, climate uncertainty will compound political uncertainty, resulting in delayed implementation of development programmes and raising the cost of finance. The process of procuring renewable energy in South Africa, for example, exposed vested political interests in the coal industry. The result was management inconsistencies that resulted in a rating agency downgrade of the state-owned utilities assets in 2015 (UNFCCC, 2015).[8]

African cities have limited scope for influencing the current rate of global warming. The continent's current urban emissions are low (1.8 t CO_2 per capita) – only South Africa's cities have per capita emissions above the global average – and have a negligible bearing on the global effort to retain warming within 2°C (Frame et al., 2014; New, 2014).[9] The continent's emissions are, however, increasing and the current choices of Africa's planners, engineers and architects will inform the carbon intensity of Africa's growth and the extent to which the world overshoots the 2°C target. Global carbon sinks, which currently remove half the global annual emissions, are already saturated (and losing capacity in some instances). If all of Africa's inhabitants in 2100 emit at the current level of the continent's most intense emitter (South Africa at 8.2 t CO_2 per capita), this would add 1°C to the global mean temperature in 2100 (New, 2014). As such, the urban development choices adopted in African cities in the next decade will not only affect urban residents, but will have global implications.

4. Harnessing urbanisation for inclusive growth – a climate-smart development model

Africa's cities grow by over 22 million people annually, and 11 million Africans enter the labour market for the first time every year (World Bank, 2014). The need to provide services to a rapidly growing urban population, while simultaneously creating employment, competing in a carbon constrained global economy and managing the concatenation of biophysical and institutional climate-change risks, represents a definitive challenge for the continent.

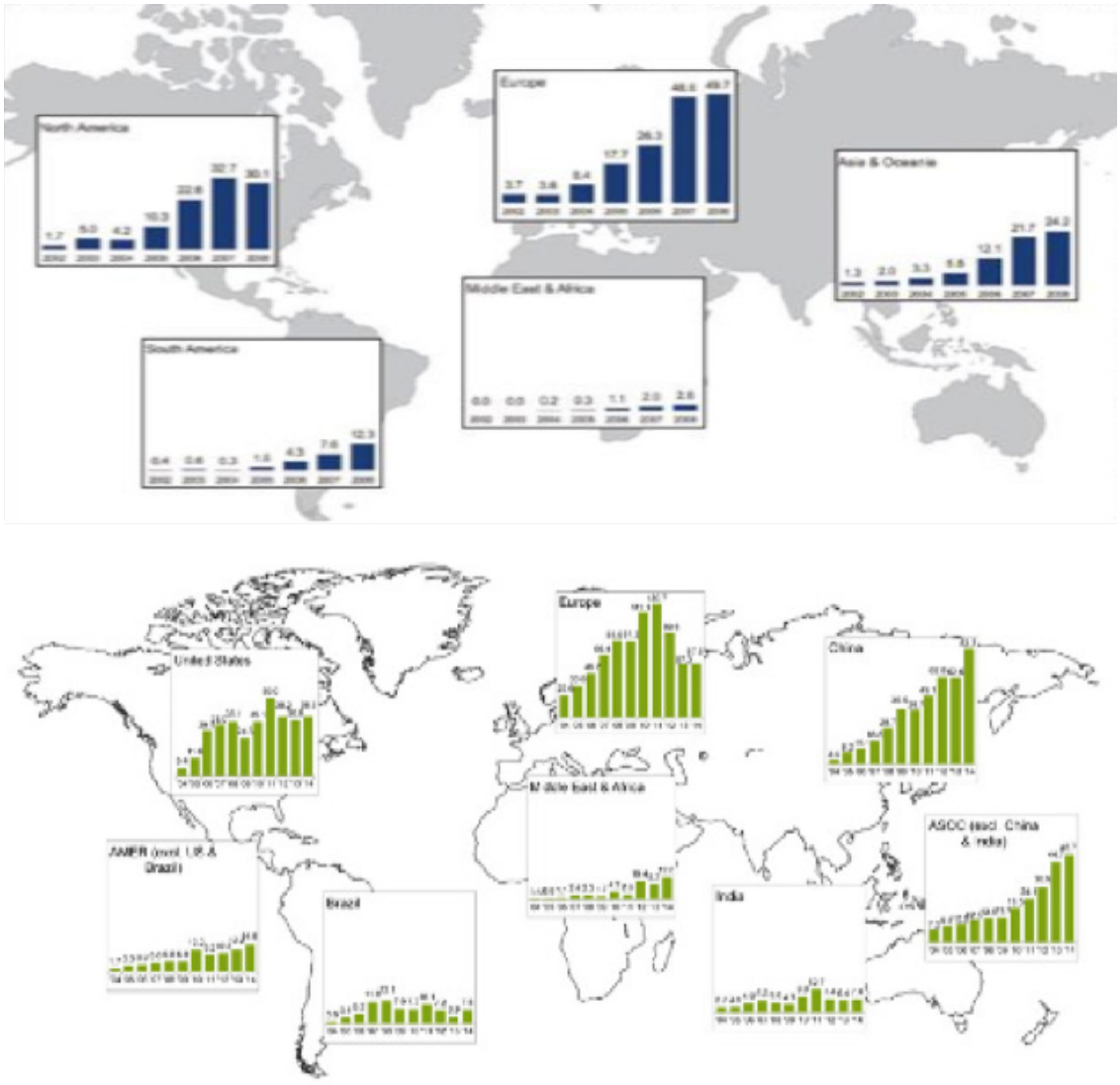
Against the backdrop of the recent period of commodity-driven economic growth, many African leaders are understandably reluctant to adopt statutory carbon constraints. There is, however, interest in alternatives to the energy, transport, water and waste management impasse among the populace that has grown frustrated with the cost, delays and inadequacy of centrally prescribed services. There is similar interest in the potential to "leap-frog" towards a more sustainable and competitive low-carbon economy, especially among those disillusioned with Africa's deteriorating terms of trade in increasingly long global-commodity chains.

Driven by a combination of absolute need and the quest for new economic competitiveness, and in some instances supported by international networks such as ICLEI, C40 Climate Leadership Group and Cities Alliance, some African cities have begun exploring alternative, more appropriate modes of service delivery, many of which are low-carbon and climate adaptive (Kaggwa et al., 2013; UN-Habitat, 2014). On the contrary, the adoption of low-carbon service delivery technologies in African cities shows that climate-smart development can be growth enhancing, giving credence to the New Climate Economy estimates that between 50-90 per cent of the measures required for a "two degree pathway" could also secure an economic benefit (NCE, 2014), and the claims of Beinhocker et al. (2008) that a quarter of the 27 Gt CO_2 that needs to be taken out of the global economy annually,[10] could be removed while securing an economic benefit.

Africa's primary interest in climate-adaptive cities is based not on their low-carbon potential, but on their ability to address the backlog of infrastructure and services by overcoming the conventional fiscal and governance challenges. This interest has been fortified by the success of renewable energy companies such as Suzlon in India and Sinovel in China and the international capital flows that have followed them. In 2014, $131.3 billion was invested in developing countries' clean energy (up 36 per cent on 2013), $89.5 billion of which came from China, a rise that has highlighted new opportunities for developing countries in the green economy (Bloomberg Business, 2015). In addition, smaller companies such as M-Kopa Solar, Uganda's SolarNow, Kenya's East Africa Solar and a variety of waste handling, sewerage treatment, and household-scale energy initiatives such as South Africa's AgriProtein[11], have drawn attention to new decentralised service-delivery models that attract investment, nurture local businesses and create employment. An ILO study estimated that Mauritius' green economy is 30 per cent more labour intensive per unit of GDP than the island's brown economy (Sultan and Harsdorff, 2014). Tunisia's solar-thermal programme, PROSOL, is supported by 42 local tech companies and over 1,000 local installation companies (UNEP, 2015). This model of urban development is endorsed by UNEP's assertion that the "low-carbon, resource efficient and socially inclusive" economy represents not only the best, but the only viable economic development pathway for developing countries (UNEP, 2011).

Figure 6

Comparison of renewable energy investment 2000–2007 (above) and 2000–2014 (below) illustrates Africa's recent emergence, off a low base, in attracting this investment



Source: Bloomberg NEF, 2008, 2015.

There are, as yet, no definitive city-wide precedents but the emerging efforts highlight how inclusive, safe and prospering African cities might take shape. Documenting this immergence is an important first step in identifying and understanding the options available to African cities.

4.1 ENERGY SERVICES

The 910 million people who live in sub-Saharan Africa currently consume less electricity than the 4.8 million people who live in the state of Alabama (*The Economist*, 2015). Economic growth and demand for energy are tightly correlated, and Africa's human poverty is characterised by energy poverty. Limited access to electricity entrenches under-development by restricting learning opportunities, making water purification unaffordable, increasing the cost of industrial opportunities and increasing the burden of disease (Foley, 1990; Venkataraman, 1990; Svensson, 1999). Africa's urbanisation and economic growth is driving demand for energy on the continent, but Africa's cities have historically had very little influence over energy generation. This is beginning to change as new technologies and critical need combine to create opportunities and fracture the continent's energy regime.

Keeping apace of electricity demand in Africa requires an additional 7 GW of capacity to be installed per year, but in the decade prior to 2005 the mean annual addition to capacity was less than 1 GW.

How African cities set about trying to bridge the electricity deficit will influence both the likelihood of success and economic prospects (Godfrey and Zhao, 2014). Africa's energy sector is dominated by state-owned utilities, many of them with dual monopoly and monopsony power. The continent's energy poverty is in part the result of the way in which these utilities have been managed and their continued reliance on coal and hydro mega-projects such as Inga (39 GW); Grand Ethiopian Renaissance Dam (6 GW), Cahora Basa (207 GW); Medupi (4.8 GW) and Kusile (4.8 GW).

In 2012 the installed capacity of sub-Saharan African utilities was 76 per cent hydrocarbon, 22 per cent hydropower and 2 per cent nuclear.[12] Sixty-nine per cent of Africa's urban population is connected to the grid (AfDB, 2011), but grid-reticulated electricity in sub-Saharan Africa is twice as expensive as in Latin America and three times as expensive as in Southeast Asia (Eberhard et al., 2011). The inefficiency of state-owned utilities costs sub-Saharan Africa 0.68 per cent of GDP, and if operational efficiency, revenue collection rates, transmission losses and staffing levels at the region's state-owned utilities were standardised with international norms this would realise $8.2 billion in efficiency gains (Eberhard et al., 2011).

Africa's grid electricity is also notoriously unreliable. Nineteen African countries experienced an average of 10 or more economically debilitating electricity outages per month in the period 2005–2008 (Lighting Africa, 2013), and outages cost firms an average of $307 per hour in sub-Saharan Africa (Eberhard et al., 2011). Many African cities rely on expensive "emergency power" providers (often running diesel generators from mobile shipping containers) to make up shortfalls required for critical water purification, effluent treatment and event management.

Providing electricity to the 587 million Africans who do not have access would require an estimated $120–$160 billion in investment each year for the next two decades (Aghion, 2014; WEO, 2014; Godfrey and Zhao, 2015). Users are not able to fund this capital, state-owned utilities do not have the required money, and large state-guarantees to these utilities are economically destabilizing. Much is made, for example, of Southern Africa's coal reserves, but only 7 per cent of the people that currently lack access to electricity in the sub-region live in countries with these reserves. Converting the coal reserve into electricity access requires expensive up-front investment in transmission infrastructure.

Some of the challenges confronted by Africa's utilities are germane to global utilities (GEI, 2014). What sets Africa's energy sector apart is the opportunity to take both urbanisation and climate change into account in planning for energy access, and the ability to draw on the rapidly expanding array of energy technologies in providing base-load electricity, influencing demand and supporting economic growth.

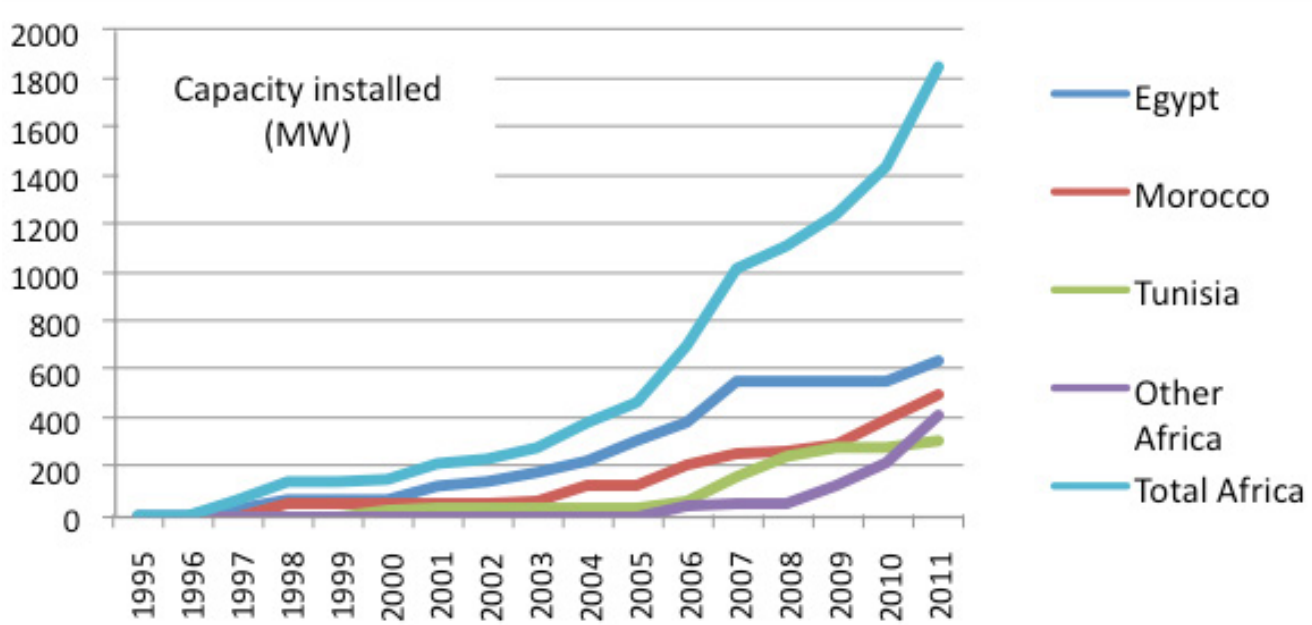
The extent of Africa's electricity deficit requires that large-scale utilities continue to play a role in providing base-load, but alternatives to inefficient, capital-intensive fossil-fuel-dependent projects with long lead times have begun to emerge for these utilities. In sub-Saharan Africa, total electricity generation from renewable sources grew by 72 per cent from 1998–2008 and 66 per cent of new electricity capacity generated after 1998 was sourced from renewable technologies (UNEP FI, 2012). In 2013 more renewable energy projects were commissioned in Africa than in the preceding thirteen years (Bloomberg NEF, 2014), and the International Energy Agency predicts that $7 billion a year will be spent in Africa between 2014 and 2020 on renewable energy, which should be compared to the $2 billion a year spent between 2000 and 2013.[13]

New renewable energy projects have reduced the exposure of national and local budgets to the volatility of commodity prices and have been located close to urban demand so as to reduce transmission losses. Notable examples include:

- South Africa's procurement of 3.7 GW of renewable energy between 2012 and 2013, ahead of time and within budget. This energy, much of which has been funded by the private sector, was delivered on schedule and has provided South Africa with a partial reprieve from the supply and fiscal constraints that afflict the national utility. Significantly, the cost at which solar and wind energy was procured dropped by 68 per cent and 42 per cent over the 3 rounds of procurement (2011–2013). In the third round wind energy was procured at ZAR 0.66 ($0.06) per kWh and solar at ZAR 0.88 ($0.08) per kWh, which is cheaper than the cost of recently commissioned coal-fired power electricity in South Africa (ZAR 0.97, or $0.09, per kWh).
- The North African countries of Morocco, Egypt and Tunisia having collectively installed 1.4 GW of renewable energy in the past three years, most of it wind.
- The Lake Turkana Windfarm in Kenya, which will supply 300 MW of power in 2016, will comprise 17 per cent of Kenya's installed power.
- A number of small-scale photovoltaic and off-stream hydroelectric power schemes in Ethiopia (Nile Hydro Project 6 GW), Rwanda (Agahozo-Shalom solar 8.5 MW), and Kenya (East Africa Solar 2 MW).

Figure 7

Increasing wind-energy capacity in North Africa and Africa (1995–2011). These data predate South Africa's renewable energy procurement programme, which has added a subsequent 800 MW.



Source: Africa Energy Outlook and REIPP.

Urbanisation offers economies of scale when extending electricity to African users, but cities' most immediate contribution to energy security lies in managing electricity demand, especially peak-demand for electricity that typically draws on emergency power generation and can be an order of magnitude more expensive than base load.[14] Cities can do this by ensuring efficiency of local transmission, building regulations, managing the urban form and in the pricing of electricity to end-users.

Electricity demand-side management is being aided by technological innovation. Simultaneously falling diode (used in LED lights), photovoltaic and battery prices have allowed households and local governments in Africa greater access to energy in spite of limited or no grid connection. On average, Africa has 325 days each year on which incoming radiation exceeds 2,000 kWh per m^2 (UNEP, 2015). In Morocco the national the wind energy programme has been complemented by the city-scale Jiha Tinou (meaning "My Region") programme promoting household-scale energy efficiency through solar water heaters, roof insulation and energy-efficient light bulbs (ADEREE, 2012). Similarly, in South Africa demand-side management has been encouraged with subsidies and pricing instruments, in a process that has reduced the quantum of electricity that utilities are required to supply. The sale of "quality approved" solar installations in sub-Saharan Africa almost doubled within the year 2014, to reach 4.1 million units. The International Finance Corporation claims that household-scale solar has already provided lighting to 5 per cent of Africa's un-electrified population (Lighting Africa, 2013). There were 850,000 solar lanterns sold in Kenya alone in 2014, and the manufactured cost of these lanterns fell by 40 per cent between 2010 and 2014 (Lighting Africa, 2014). The International Energy Agency estimates that solar power will provide at least 200 watts per head – enough for lighting or charging a smart phone – to 500 million Africans by 2030 (IEA, 2013).

Private companies such as M-Kopa Solar, M-Power and SolarCity that sell household-scale energy technologies are circumventing the need for transmission infrastructure and energy governance, while meeting a need created by the high price that households currently pay for limited, unsafe energy. Off-grid households in East Africa spend about $0.50–$0.60 per day (13 per cent of their household income) on kerosene for lighting and cooking – the unit cost of this energy can be as much as $100 per kilowatt hour – and run the daily risk of indoor fire and air pollution (IEA, 2014; *The Economist*, 2015). Kerosene and biomass accounted for an estimated 600,000 premature deaths in Africa in 2013 (IEA, 2013). In addition, the burning of kerosene emits 30–50 million tonnes of CO_2 in Africa (Lighting Africa, 2010). In contrast, Kenyan families using solar lanterns saved $1 per day (UNEP, 2015). In Nairobi, where the national government has removed VAT on photovoltaic products, a micro-industry of solar entrepreneurs leases lighting and mobile phone charging to those that cannot afford panels. Similarly, solar water heaters, heat-pumps and efficient biomass stoves, financed variably by local governments, national governments and development agencies, have reduced demand for formal electricity and improved energy services to off-grid and energy-poor households.[15]

Technology is also creating options for urban-scale electricity generation as cities look to meet their own demand and earn revenue by supplying regional energy pools. In Durban, the eThekwini Municipality has used its legal mandate for managing the 1.8 million tonnes of solid waste produced by the city annually to construct two landfill gas-to-electricity projects at Bisasar Road (6.5 MW) and Mariannhill (1 MW). When initiated in 2003, the cost of producing electricity at the sites was more expensive than the coal-fired electricity purchased by the municipality from the national utility. This has changed in the ensuing 12 years as electricity in South Africa has become more expensive, and the option of a local source has enhanced electricity security for the adjacent areas in the wake of outages. The project reduces greenhouse gas emissions (predominantly methane from the landfill sites) by an estimated 3.8 million tCO_2 over a 21-year period. In Nigeria, Lagos State Government has begun a similar biogas initiative using food waste as a feedstock. The project is capable of delivering 25 MW of electricity to local communities.

The shift towards urban electricity generation and renewable energy generates critical urban employment. The numbers are contested, but two South African studies (Austin et al., 2003; WCPG, 2007) indicate the labour intensity of renewable energy sources relative to coal, nuclear and gas (Table 3).

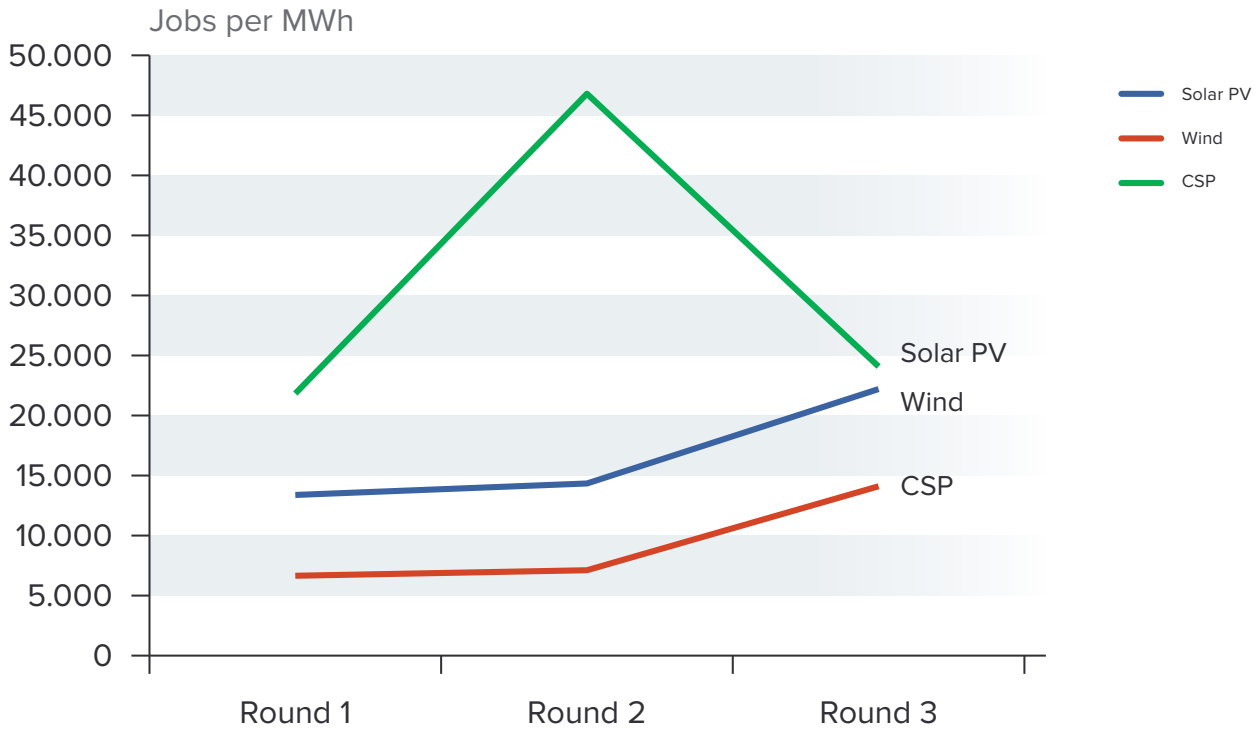
Table 3
Jobs per GWh for different electricity feedstocks

Electricity feedstock	Jobs per GWh
Coal	0.30-0.70
Nuclear	0.08-0.2
Gas	0.10-0.13
Solar thermal	8.70-10.40
Photovoltaic	6.20
Wind	5.60
Landfill gas	23.00
Bioethanol	3.80

Source: Austin et al., 2003; Western Cape RE Plan, 2007

In South Africa, the three rounds of renewable energy procurement generated increasing labour intensity per unit of electricity produced, as local capacity was created and used to substitute imported components and skills (see Figure 8). Where cities take on generation opportunities they relocate employment from centralised utilities to their urban economies.

Figure 8
Labour intensity of South Africa's three rounds of renewable energy procurement showing a trend towards greater local labour employment over time



Source: Eberhard et al., 2014; own calculations.

It is the ability of renewable energy (much of which is modular and can be scaled accordingly) to shorten lead times for electricity supply and to address generation, distribution and demand problems in Africa's cities that make it well suited to the continent's urban challenge. The net result is an energy revolution on the African continent in which State-owned utilities are being undercut by localised energy generation, and cities and households are filling the electricity distribution gap left by nationally operated utilities. The change is being driven by technology and seems inevitable, but the pace and extent to which it makes a meaningful contribution towards urban energy security will depend on the degree to which national governments are prepared to divest themselves of the political and economic influence they exercise through state-owned energy utilities.[16]

In the short term the manner in which Africa's energy regime is diversified may be determined by the recent gas finds in East and Southern Africa. This gas offers the option of being used in power generation, for industry, for transport and for household use. Where the generation and transmission infrastructure built for gas is compatible with the long-term goal of a decentralised renewable energy supply (i.e. multiple off-take points, decentralised power generation, mini-grids that enable a two-way flow of electricity between end-consumers and the grid, linked to transport fleets), this could pave the way for Africa's abundant renewable energy resources and the development of urban energy sectors (Petrie, 2015, pers. comm.). A critical short-term need involves protecting the nascent urban energy sector from anti-competitive behaviour by vested interests, so as to allow for the uptake of new, rapidly evolving renewable technologies at the local scale. Failure to do this will see African cities locked in to expensive, dirty and uncompetitive development pathways.

4.2 SPATIAL PLANNING

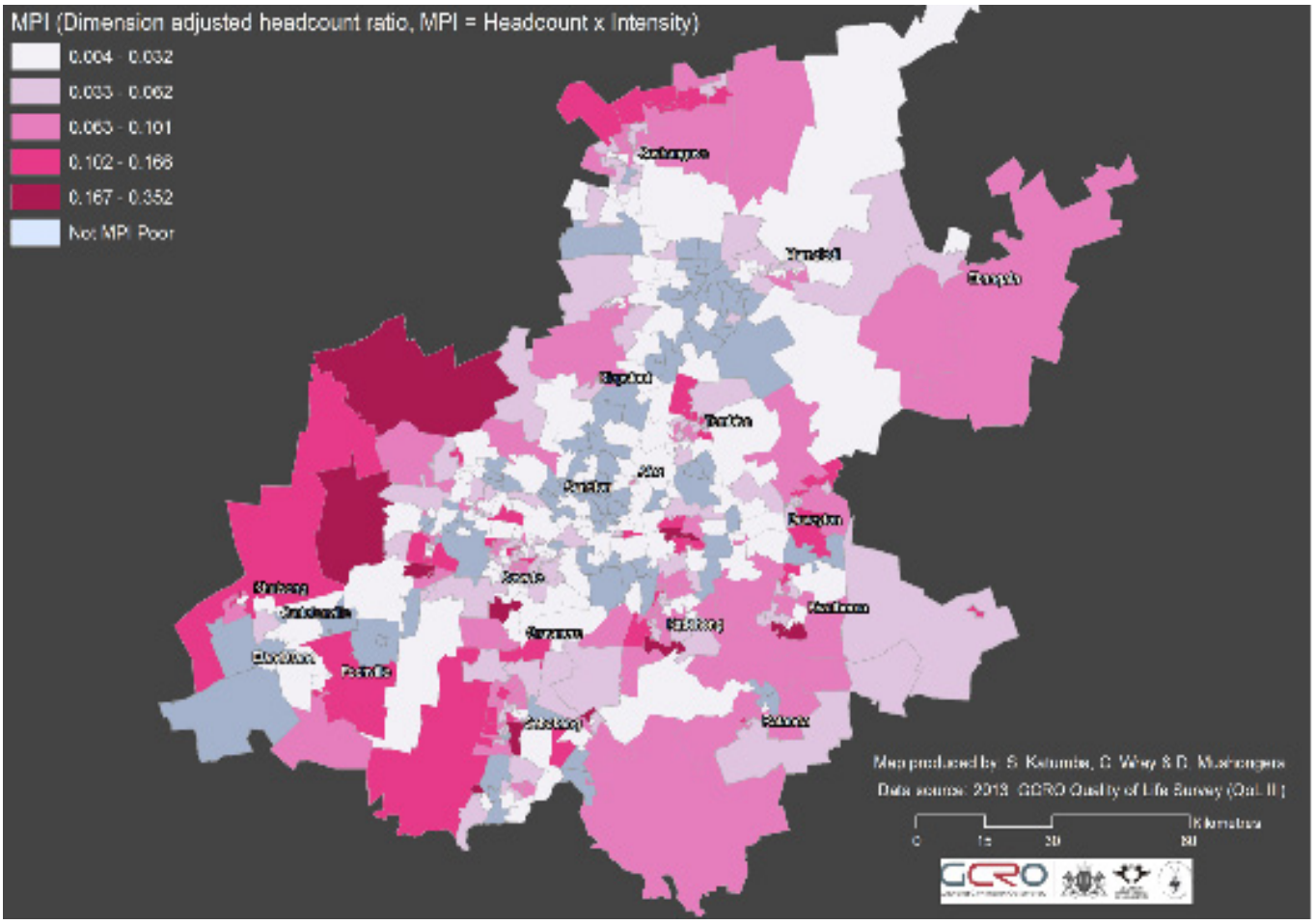
Compact cities concentrate economic and social interactions, create viable markets and reduce the unit cost of service delivery in what UN-Habitat terms the "agglomeration advantage" (Rosenthal and Strange, 2003; Glaeser, 2011; UN-Habitat, 2012b; Todes, 2013; Rode and Floater, 2014). For example:

- New evidence by the World Bank suggests that an increase in urban densities to 10,000 from 2,500 people per square kilometre, reduces the requirement for water infrastructure from 5.5 metres per person to 3.5 metres (World Bank, 2014).
- Urban development based on compact, multi-story buildings in mixed use neighbourhoods can offer a 6-fold improvement in neighbourhood energy efficiency (including transport) relative to detached houses (Rode et al., 2014).
- The fiscal viability of public transport, public service provision and urban regeneration projects depends heavily on compact cities in which commuters are given the opportunity to interact with retailers in the first and last mile of their commute (Todes, 2012; Rode and Floater, 2012).
- New estimates of urban sprawl suggest that a model of development based around private vehicle travel is very costly. Urban sprawl in the United States, for example, costs private individuals $625bn each year and imposes a $400bn additional burden on the fiscus (Litman , 2015).

A number of informal settlements in Africa are already dense, but Africa's urban economic growth has been accompanied by a proportionately greater growth in urban footprint and African cities tend to lack the internal connection and planning cohesion that enables the efficient movement of people and goods. The result has been increasing distance between residents and work opportunities, increased cost of service delivery, strained public funds and the destruction of ecological services. UN-Habitat estimates that each new urban resident in the developing world requires an additional 160 m^2 of rural land. The sprawl that has taken place in Africa is a symptom of poor spatial planning and weak land governance that has been exploited by property developers and their quest for greenfield settlements, by businesses and affluent residents seeking to distance themselves from congested and polluted inner-cities and by new informal residents occupying land that is cheaper, vacant and sometimes under insecure tenure on the outskirts of the major cities (Parnell, 2015; Cain, 2015). The trend is a challenge for Africa's urban planners. Certainly the capacity to oversee land zoning and human settlement in most African cities has been overwhelmed by the speed and scale of in-migration combined with the resulting informality that by definition operates outside of the established channels of land ownership and development applications (Kotlin, 2011).

Figure 9

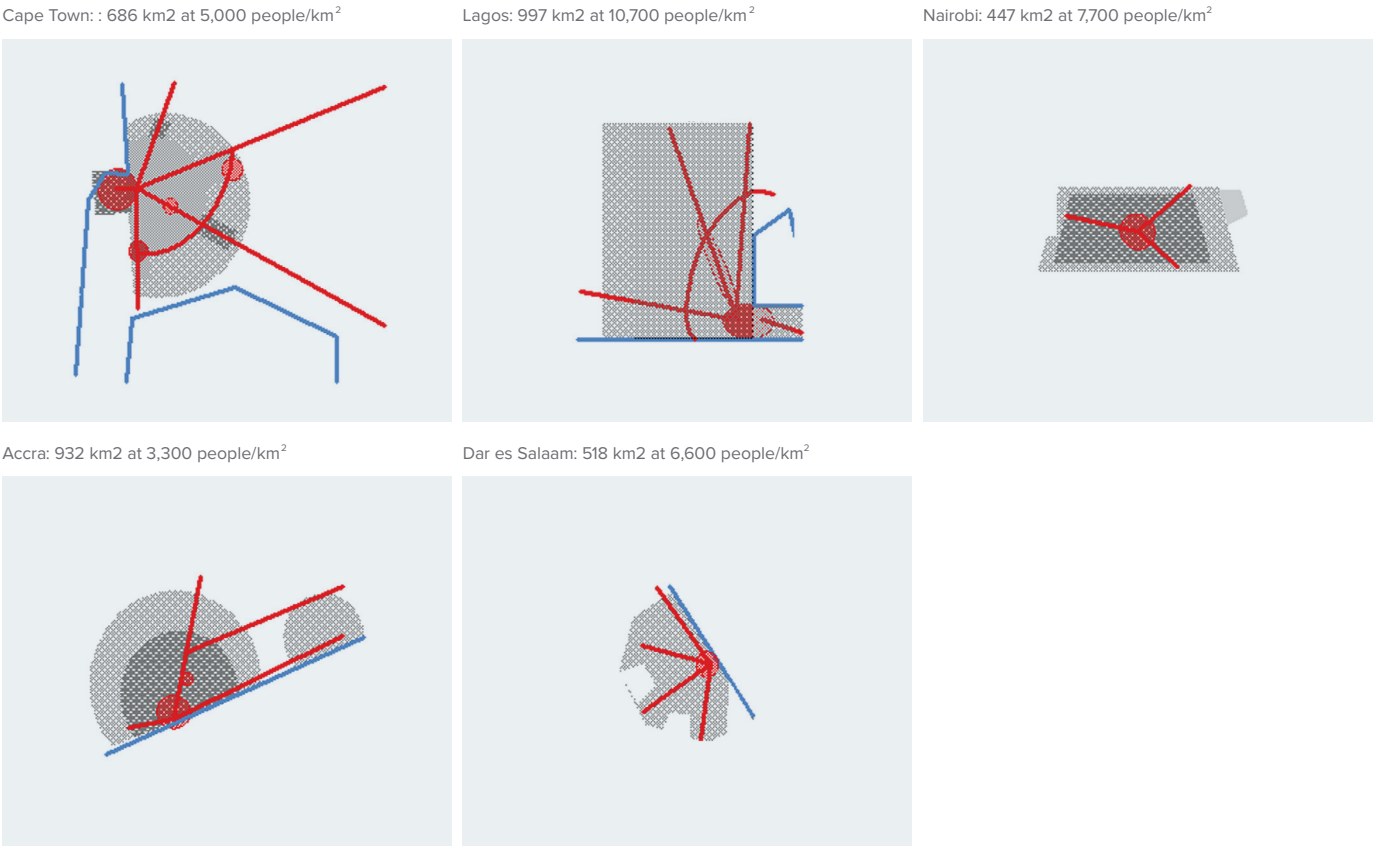
A map indexing "multiple deprivation" in the City of Johannesburg illustrates the global norm of greater deprivation on the outskirts of the city. The unit cost of providing services to these residents represents an increasing fiscal burden.



Source: GCRO, 2015.

Cities such as Cape Town have tried, largely in vain, to apply cartographic and regulatory instruments such as an "urban edge" in an attempt to promote a more compact and connected urban form. In the context of rapid urbanisation and high levels of informality, the alignment of investment in basic services, transport infrastructure and public transport appears to be more effective in influencing where people settle and conduct their business and ultimate spatial form, than straight land zoning legislation (Todes, 2015).

Figure 10
Form, area and density of select African cities showing the extent of variety



Source: Palmer and Ferro, 2011.

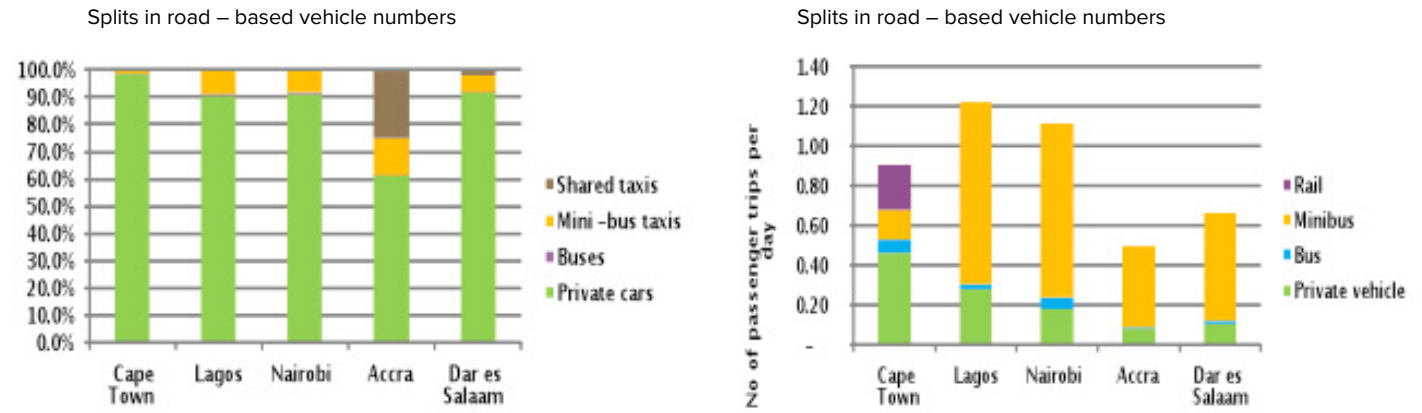
In this way the strategic location of critical services can be used to shape urban density, which in turn affects development opportunities, the cost of providing services and greenhouse gas emissions (Litmann, 2014; Parnell, 2015). The provision of services can also be used to create urban identities. Rio de Janero's slum upgrading – *Favella Bairro* – initiated in 1996, was able to engage informal communities around strategic sanitation, transport and drainage infrastructure decisions and the creation of public open spaces, especially multi-purpose streets. Adapting these lessons for African cities in the context of climate change, new energy, sanitation, waste collection and transport technologies, provide far-sighted urban planners with the ideal catalyst for engaging urban communities in service-delivery decisions and in "place making" (Behrens and Watson, 1996; UN-Habitat, 2012b). In Cape Town the "Open Streets" programme converted public streets into pedestrianised markets and public gathering places – including in poorer communities – on designated days (see www.openstreets.org.za). Similarly, UNEP's "Share the Road" initiative, which has been piloted in Nairobi, Kigali, Bujumbura and Kampala, highlights the importance of commuter routes that are safe for pedestrians, bicycles and the retailers that engage these commuters and generate commercial-property revenue for the local authority. This has been achieved inexpensively with painted road markings and signage, which can be removed if unsuccessful or at specific times of the day or year.

4.3 TRANSPORT

Transport and urban form are integrally connected and collectively determine transport-related emissions in cities. Walking and bicycles account for over 70 per cent of "trips" in African cities. This non-motorised mobility is climate friendly, reduces the land requirement for roads and parking in cities and is relatively safe. It also, however, accounts for low mobility of people and goods.

The extent of car ownership varies across Africa's cities (see Figure 11), but remains below 6 per cent on average, which is one of the reasons for the continent's low per capita CO_2 emissions. Minibus taxis account for the greatest number of trips in

Figure 11
Form, area and density of select African cities showing the extent of variety

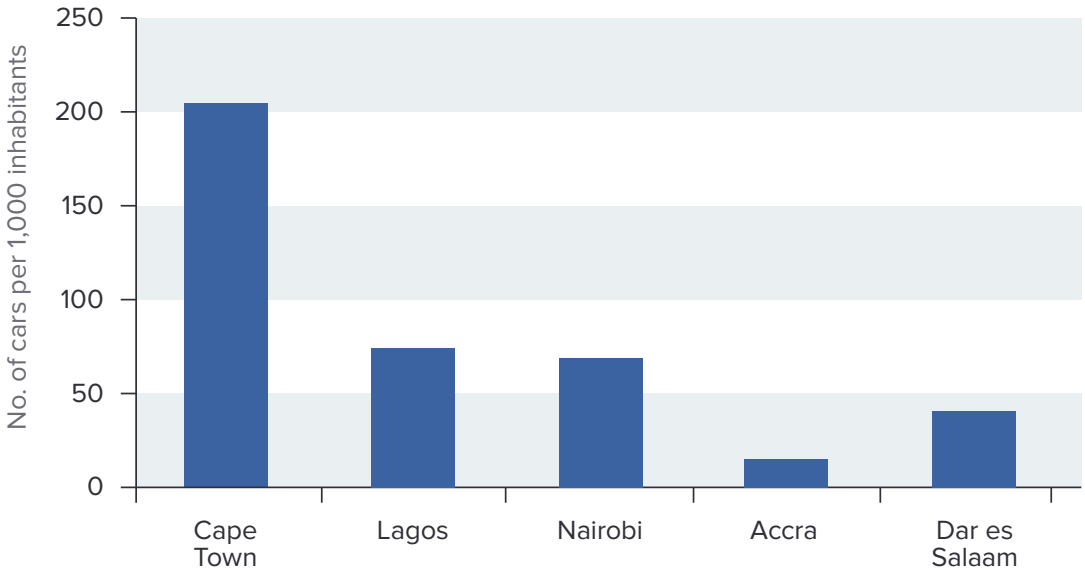


Source: Palmer and Ferro, 2011.

most African cities (see Figure 11), but there remains pent-up demand for mobility. Rising car ownership has been a feature of all growing urban economies on the continent and has put the available road infrastructure under pressure while encouraging sprawl (Todes, 2012; Litman, 2014; Palmer and Ferro, 2014; World Bank, 2014). In Africa's most notoriously congested city, Lagos, there are only 70 cars per 1,000 residents and 180 vehicles per kilometre of paved road (fewer than in Cape Town, Nairobi or Dar es Salaam), but a 2009 study estimated that commuters in Lagos lose 3 billion hours to congestion every year (EIU, 2013). The same study estimated that a 20 per cent reduction in congestion would inject $1 billion into the local economy annually.

The presence of vehicles in the midst of the pedestrian majority contributes to high road-fatality rates on the continent (Behrens, 2014). Africa has 2.8 per cent of the world's vehicles but 11.1 per cent of road fatalities. In Nairobi two thirds of all road deaths are pedestrians. There are 322 road fatalities per 100,000 vehicles in Africa (380 in East Africa, 350 in West Africa and 170 in Southern Africa)[17] and road deaths, which affect the economically active disproportionately, are estimated to cost the continent 1–3 per cent of GNP (WHO, 2011).

Figure 12
Cars per 1,000 people in major sub-Saharan African cities



Source: Palmer and Ferro, 2011.

Cars are a particularly inefficient form of urban mobility (Rode and Floater, 2014), and poor fuel-quality regulations (many African countries burn a grade of petrol that still contains lead and has over 10,000 ppm sulphur) means that the existing cars cause high levels of urban pollution (SEI, 2013). In African countries that do not have crude-oil refining capacity, rising car ownership has also exposed the economy to the vagaries of fluctuating global sweet-crude oil prices.

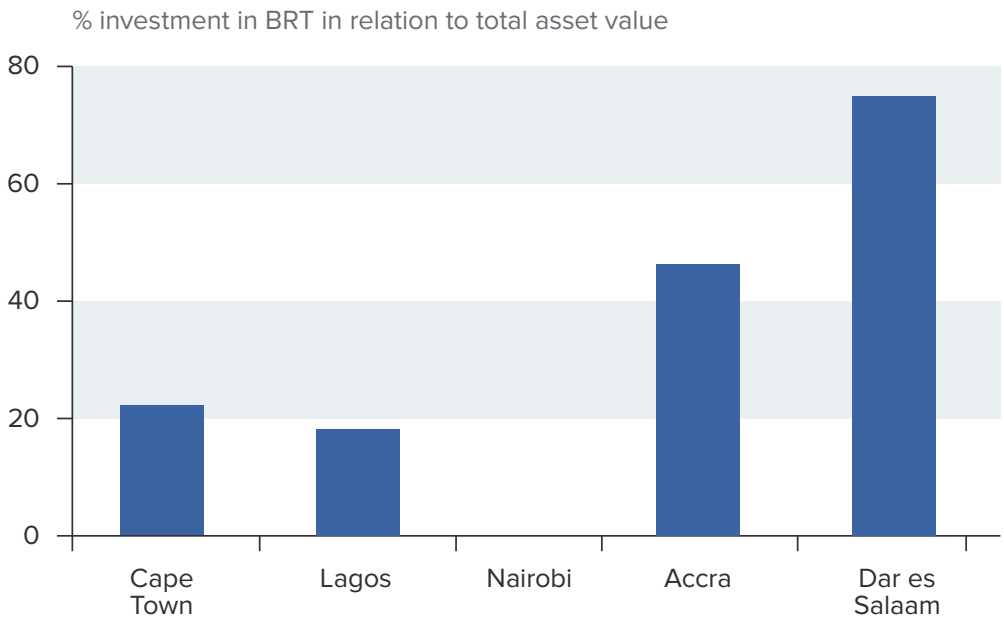
Ironically, while the state of mobility in Africa's cities comprises an economic and environmental burden, it also provides a platform for low-carbon transport to fulfil its strategic role in delivering economic growth. Recent efforts in Nairobi, Lagos and Kinshasa show that you cannot construct your way out of inner-city congestion with more roads and fly-overs. The transport hope for African cities is that urban commuters, the majority of whom currently rely on walking, buses and minibus taxis, will leap-frog the hyper-motorisation phase of socio-economic development that has proven costly and environmentally damaging in OECD cities, and be enticed onto efficient public transport through what Haq and Schwela (2012) call "traffic demand management". Where successful, this will ensure commuters cover the "last mile" on foot, thereby generating important retail markets at their journey end-points.

A number of African cities (Cairo, Cape Town, Johannesburg, Lagos, Nairobi, Dakar and Dar es Salaam) are looking to emulate the South American cities of Curitiba and Bogota and implement bus rapid transport (BRT) systems. The most advanced schemes in Africa have only been running for three years, but have begun to reduce congestion,[18] make commuting safer and enhancing mobility. But BRT has also imposed new fiscal burdens on local authorities (see Figure 13), in part due to the lack of critical urban density and complementary spatial planning, vehicle taxes, fuel levies, congestion charges and metred parking for private vehicles – measures required to ensure their success (Behrens, 2014).

Lagos' relatively successful BRT programme, which is run by the local transport authority LAMATA, demonstrates the potential for cost savings when the focus is on creating dedicated road space for mass mobility rather than specifying or controlling the vehicle fleet. Lagos' BRT-lite system created a deliberate role for the 75,000 minibuses and taxis that had been transporting people prior to the BRT system. This reduced the number of buses required and the fiscal burden. In addition, not all BRT lanes involved concrete curbs, with some designated by painted road markings for specific times of day. As a result, Lagos' BRT cost $1.7 million per kilometre of road space, compared to an average of $6 million in South Africa's cities (Palmer and Ferro, 2011).

Figure 13

The fiscal burden of respective BRT systems relative to the total asset value under the control of the local authority



Source: Palmer and Ferro, 2011.

The co-ordination of BRT systems with urban density and complementary measures such as the restriction of inner-city parking and the removal of parking subsidies for executives and local government officials can support the financial viability of urban public-transport efforts. In Nairobi, an estimated 5,000 cars enter the central city everyday and park on the streets, but only 43 per cent of these pay for their parking (Nairobi News, 2015). Similarly, efforts to tax the increases in property value that are generated by public-transport extensions are being explored in Cape Town and Johannesburg as a means of financing their respective BRT systems. The emergence of "transit oriented development" (UN-Habitat, 2012b) strategies on the continent seeks to harness the potential created by transport nodes for generating other development opportunities, some of which can be used to offset the cost of public transport.

Connecting commuters with retail opportunities during the "last mile" of their commute is an important part of vibrant and commercially viable cities. Existing reliance on pedestrian and bicycle trips makes this easy in African cities, and public transport systems should be designed to retain this feature. In Dakar, the *Place de l'Obélisque* has been converted into a pedestrian and retail walkway via a labour-intensive paving programme. In other cities, pedestrian and retail space can be designated via simple road markings or with shelters from sun and rain over pavements. In Cape Town's St Georges Mall a central street is converted into a vibrant but temporary local-produce food market for three hours every Thursday.

4.4 WASTE MANAGEMENT

Cities concentrate consumption, drawing on resources from beyond their borders and producing large volumes of waste. Managing urban waste requires a logistics fleet, landfill sites and machinery for managing landfills. Landfill sites are also a source of water contamination and methane. In Cape Town, depositing waste in landfills costs the municipality $70 per tonne (De Wit, 2012). Urban sprawl increases this cost due to the land footprint from which waste must be collected.

In almost all cities solid-waste management constitutes a net cost, but in many African cities the fiscal burden of solid-waste management is untenable. Unfortunately, the default – in which waste is left uncollected – blocks stormwater drains and exacerbates flooding, festers disease and encourages the indiscriminate burning of solid waste, which emits dioxins and short-term greenhouse gases (black soot and methane) and causes severe human health damage (Shindell et al., 2012).

A number of private-sector and community-led initiatives in African cities demonstrate that managing urban solid waste can generate new economic activity. Waste picking on the Lagos' Olusosun landfill site provides daily work for over 5,000 people who have limited prospects in the formal job market. The work is dangerous and unhealthy, but it does reduce the burden of waste on the site by an estimated 3,000 tonnes per day and limits the demand for virgin material and extractive industries. As with many waste-picking enterprises on the continent, the Lagos waste pickers operate outside of the formal waste economy and find themselves in conflict with city officials. This is in spite of enhancing the efficiency of the waste stream and providing a service that the local authority would otherwise have to pay for.

A number of innovative businesses have emerged to address the problem of Africa's growing urban waste stream, sometimes supported by public sector contracts. Examples include:

- Reliance Compost company, which is contracted by local municipalities in the Southern African region to remove green waste, which it turns into organic compost for sale to the agricultural and landscaping sector. In the City of Cape Town alone, Reliance Compost employs 220 people and saves 180,000 t CO_2e worth of emissions annually (Credible Carbon, 2014).
- AgriProtein has used municipal waste as a feedstock in breeding fly larvae that are high in protein and fat. The larvae are sold to livestock and poultry farmers so as to reduce their dependence on fishmeal and scarce fish stocks.
- Government-facilitated Industrial Symbiosis Processes (ISPs) that connect local industries that are able to use each other's by-products (Green-Cape, 2014).
- In Kampala, a city in which only 40 per cent of the residents have their waste collected, the support, by the local authority, of community involvement in solid-waste collection and recycling as a means of preventing drain blockages and flooding and the contamination of Lake Victoria (KPDP, 2012).

The emerging waste economy converts the burden of waste management into economic opportunities and renders cities more resource efficient (Hoornweg and Bhada-Tata, 2012). Recycling and up-cycling can be particularly effective in Africa's cities defined by socio-economic activity. Discards from affluent households are readily assimilated into poorer communities. The need for labour-intensive activities in the "first and last mile" of the urban waste stream creates the potential for local, low-

skilled work that also reduces environmental and public-health risks. Existing efforts can be supported by at-source separation of putrescible waste fractions so as to enable safe recycling (and up-cycling), the allocation of space for waste-recyclers and the public procurement of energy produced by waste-to-energy incinerators and biodigesters.

4.5 SANITATION, STORMWATER AND WATER PROVISION

"Water is life, sanitation is dignity", and the provision of potable water and treatment of human effluent is critical to reducing Africa's urban disease burden and to the formation of positive urban identities (Eliasson, 2014).[19] Water scarcity and sanitation deficits were ranked as the global risk with the highest impact and ascribed a very high likelihood (WEF, 2015).

The availability of water varies greatly across the African continent. Urbanisation in sub-Saharan African has been linked to economies of scale and improved water services: 83 per cent of Africa's urban population has access to improved water services, compared to 53 per cent in rural areas (World Bank, 2014). Treatment of effluent, however, has not kept up with the rate of urbanisation in most African cities, leading to the degradation of water resources. Only 40 per cent of urban Africans had access to sanitation services in 2012, and this proportion had not changed since 2002 (World Bank, 2015). Many cities on the continent still rely on infrastructure that was built during the colonial period, which requires scarce electricity to operate, is inadequate for the number of people it serves and in which stormwater and sewerage systems are linked. The vicious circle that ensues sees authorities paying high costs for the extension of reticulated water and water treatment, while the poor have no formal sanitation or water access and effluent contaminates scarce water resources, compounding the burden of disease.

New technologies, coupled with devolved responsibility, have begun to offer solutions. Composting toilets, biodigesters and osmosis membranes offer more affordable alternatives than extensions of bulk infrastructure to residents located on the urban periphery. They also reduce the energy and maintenance costs associated with sanitation, and avoid the effluent spills that are common during times of electricity outages. The technologies have improved to the extent that they allow for comparable services to flush sanitation systems. Examples include:

- In Kibera, Nairobi's largest informal settlement, the widespread problem of "open defecation" – complete with cholera, diarrhoea, infant mortality risks, methane emissions and loss of personal dignity – is being addressed by the building of over 50 "bio-centres" that collate human slurry and convert it into biogas which they sell for cooking and water heating.
- In Uganda a nationally run "Domestic Biogas Programme" generates local energy from human slurry.
- In Durban the municipality is exploring the role of wetlands and riparian buffers in water purification and comparing the costs and quality of services provided by this "ecological infrastructure" to those provided by engineered water-purification plants.

Similarly, rainwater harvesting, permeable paving and greywater and stormwater recycling technologies have created new opportunities for the management of run-off and the provision of water. In the tropics, where intensive rainfall is a problem, technologies that manage run-off prevent flooding. In the arid mid-latitudes, technologies that allow users to distinguish between potable water and grey water address critical water constraints.

4.6 HUMAN SETTLEMENTS, BUILT ENVIRONMENT AND ECOLOGICAL INFRASTRUCTURE

Shelter is a priority for urban residents, but the way in which settlements and housing have been developed in Africa's cities has too often entrenched existing inequality and ethnic divides and accelerated environmental degradation.

While Africa's urban population will triple by 2050, the natural resource base on which this population depends will remain the same – possibly even degrade. It is the built environment that mediates the relationship between people and the natural environment. The manner in which Africa's cities are built determines social interactions, the flow of resources to and from these cities (what Abel Wolman first called the "urban metabolism"), resource efficiency and urban identities. The immediate challenge is to avoid the default, in which service-delivery infrastructure destroys the ecological infrastructure on which the urban poor depend for services.

In the absence of formal housing and built infrastructure, many residents of African cities rely on the natural environment for an array of services, including water provision and purification, extreme temperature moderation, flood buffering, building material and recreational amenities (UN-Habitat, 2012b). In Cape Town the goods and services provided by the natural environment were valued at ZAR 2 billion – 6 billion per annum (De Wit et al., 2011). Protected urban land does have a high opportunity

cost (Cartwright et al., 2013) and may entice informal settlement simply because it is seen as vacant. However, infrastructure development that seeks complementarity between built and natural infrastructure unlocks multiple benefits beyond climate adaptation and mitigation, including health benefits, reduced maintenance costs and enhanced biodiversity (UN-Habitat, 2012b; World Bank, 2014). It also creates the type of work in managing the natural environment that unemployed people can benefit from, i.e. low-skilled, local, insulated from global markets and linked to sense of place.

This approach to urban infrastructure is a greater priority than the ex post tree-planting efforts that are a feature of many cities. Successful examples of this approach include:

- A youth employment project (see the Majaoni Youth Development Group) in Mombasa, where up to 20 per cent of the city could be inundated by a 0.3m rise in sea-level, which has combined the re-establishment of mangrove flood buffers with eco-tourism and protection of natural fish nurseries (UN-Habitat, 2012c).
- The South African city of Durban, which is home to 3.7 million people, having recognised this principle in formalising its Durban Metropolitan Open Space System (DMOSS), a network of 74,000 ha. within the city that links and conserves estuarine, riparian, forest and wetland systems. The local authority maintains that the DMOSS system provides a vault for 24.7 million t CO_2e, and sequesters 31–36 thousand tonnes of CO_2 per annum, reduces the risk of river and sea-level-rise flooding, reduces the urban heat-island (with associated health benefits), supports the protection of urban biodiversity and creates a sense of place for the people who work on the programme. The use by the municipality of such a spatial planning tool to protect natural landscapes and green open spaces within the city, partially in response to climate change, has recently been legally challenged by a local property owner and developer affected by the limitations placed on land designated within DMOSS[20]. The High Court found in favour of the municipality, illustrating the importance of a supportive legislative environment.
- The Jozi@Work programme, which seeks to create neighbourhood co-operatives and micro enterprises that make entry-level workers productive. The programme involves de-sludging chemical toilets, separating and recycling waste and resurfacing and maintaining roads in the city of Johannesburg.
- The Permaculture Project in the Heliopolis neighbourhood in Cairo. This is an urban greening and farming programme prompted by the social uprising that was (nominally) catalysed by food insecurity. The programme contributes to local food supply and urban greening, but more critically provides a green open space in which previously disenfranchised youth can work, build social networks and nurture a sense of place and identity.
- The Langrug informal settlement in Franschoek, which saw the local municipality and shack-dwellers address the housing back-log collaboratively. The local government provided sites with bulk sanitation infrastructure, while community members participated in the construction of flood-mitigation measures and houses.

5. Costs and benefits of urbanisation strategies

Providing Africa's urban infrastructure (which excludes utility-scale electricity) requires an estimated $68–$93 billion per annum over the next three decades (AfDB, 2011). The conventional analysis suggests that climate change will increase this cost: The World Bank estimates that 2°C of warming would cost "developing country cities" an additional $56–$80 billion per year in 2050; in 2015 the UNEP released a report suggesting that 2°C of warming could cost Africa $50 billion per year by 2050, more recent work by Moores and Diaz (2015) suggests that previous climate-change damage estimates for Africa's poorest countries may have been too conservative.

However, not all climate mitigation options cost more or retard economic growth. China could save up to $1.4 trillion in infrastructure spending to 2030, or around 15 per cent of GDP in 2013, if it pursued more compact, transit-oriented urban development (World Bank, 2014). NCE analysis showed that compact, connected urban growth could reduce global infrastructure requirements by more than $3 trillion between 2015 and 2030 (NCE, 2015).

Surveying the options available to African cities for supplying a basket of critically needed infrastructure and services, it becomes clear that in many African cities low-carbon, climate adaptive infrastructure and services will not only be cheaper, but more suitable given the absolute infrastructure deficit and paucity of fiscal resources to pay for mega-capital and ongoing operating costs. In addition, climate-smart urban development is more likely to generate local employment, coping capacity and

virtuous economic-development cycles – what Rodin calls "the resilience dividend" – than capital-intensive alternatives that present high operating and maintenance costs (Hallegatte, 2007; Cartwright et al., 2013; Rodin, 2014).

The forging of low-carbon urban development pathway represents a definitive challenge for local authorities in Africa, but is supported by a comparison of the costs of "urbanisation as usual" relative to a "low-carbon, adaptive cities" alternative. Such analyses can further assist in identifying "who benefits" from, and "who pays" for, the building of Africa's cities, and in preventing negative externalities (including pollution, resource scarcity and rising service prices) being disproportionately loaded on the urban poor. This type of comparison is made in Table 4, below, which compares the economic costs of unplanned African urban development relative to the potential contained in low-carbon, climate-adaptive urban development.

Table 4
The case for new climate economies in Africa's cities

Cost of urbanisation as usual	Benefits of new climate economies
Energy – intermittent access and rising costs • Rolling blackouts cost in excess of $1 per kWh of foregoneelectricity. • Fiscally expensive mega-projects co-exist alongside communities without grid access that are exposed to expensive paraffin, indoor air pollution and fires. • Intra-country transmission losses continue to add 10%–15% to cost of centralised coal-fired electricity. • Educational attainment and health advances remain curtailed by power outages and energy poverty. • Ineptitude of energy monopsonies/monopolies drains fiscal resources and entrenches energy poverty.	**Energy – universal access, safe and affordable energy, local jobs** • Energy planning across the continent sees regional and feedstock integration (coal, liquid fuel, gas, biofuel, renewables and demand-side management) to expand supply and reduce costs. • Switch from coal to hydro-power saves $2.7bn in operating costs annually and supplies pumped-storage for renewable energy. • Gas reserves are harnessed to displace coal and complement renewables in Southern Africa by providing power, gas to industry, gas to transport and gas to households, sequentially as the resource and distribution is improved. • An additional 5–10 jobs are created for every GWh or renewable energy. • Jobs and new revenues from household/community energy lift people out of poverty while powering manufacturing. • Reduced transmission losses increase grid efficiency by 10 per cent. • Household PV costs less than $0.10 per kWh and reduces demand for utility-scale energy. • Household PV saves $0.50-$0.60 per household per day, saves households $300 per annum in paraffin and makes for safer energy. • Greater cost-recovery of energy enables progressive tariff models and free basic energy allowances. • Tapping urban Africa's extraordinary energy literacy and energy awareness to build urban energy community-based energy systems that extend access and distribute dividends broadly.
Urban form – sprawl, divisions and high costs of service delivery • Private-sector finance of infrastructure undermines spatial management and local tax collection, while encouraging sprawl. • Sprawl raises cost of service provision – 5 metres per person of water piping, more than $50 per tonne of solid-waste management, untenable grid-extension costs result in household paraffin use at $10–$100 per kWh. • Splintered urbanism foments urban conflict and crime and segments markets.	**Urban form – people and opportunity connect in compact and efficient cities** • Urban densities in excess of 6,000 per km2 create viable markets for public transport. • Compact form and multi-story residential buildings results in a six-fold saving in community energy, and greater disposable income for local economic development. • Use of ecological flood buffers saves infrastructure costs and flood damage.

Transport – congestion, pollution and low mobility • Road deaths rise as vehicle ownership increases and cost in excess of 3% of GDP. • Congestion undermines the mobility of people and goods and inflates the cost of doing business and finding work. • Fiscal burden of road maintenance increases faster than economic growth. • Inner-city air pollution increases the burden of respiratory disease.	**Transport – affordable safe mobility** • Immediate cost savings in the form of discontinued subsidies for parking, and heightened revenue from full capture of cost of parking. • Macro-economic stability from reduced importing of refined crude oil. • Efficient public transport reduces household expenditure on private vehicles. • Normalisation of traffic congestion in Lagos alone saves $1bn per year. Congestion reduction elsewhere follows suit. • Efficient public transport reduces inner-city pollution. • Vibrant urban economies are supported by safe pedestrian–retailer interaction.
Water and sanitation – increasing contamination • Ongoing electricity outages dump effluent and prevent purification. • Deaths from water-born diseases remain at 5 million per year and contamination increases. • Pumped sanitation system burdens the local energy supply.	**Water and sanitation – universal access to safe water and sanitation** • Widespread sanitation provided through a series of off-grid technologies and community partnerships. • Off-grid sanitation provided more quickly and cheaply than via extension of reticulated bulk-water systems. • Local energy and water savings through off-grid sanitation. • Sanitation centres become local business opportunities and save local-authority money while selling biogas to local communities for cooking.
Waste – rising cost of waste management and waste externalities • Waste increases with consumption and compounds flooding and disease burden. • Landfill sites occupy valuable land, contaminate water and impose a fiscal burden. • Waste management requires expensive logistics. • Waste management contributes to greenhouse gas emissions through logistics and landfill methane.	**Waste – new economic opportunities in waste handling** • Waste and landfill gas becomes an energy feedstock for local smart-grids, contributing to local energy security. • Waste and waste-to-energy generates new local work opportunities. • Recycling and up-cycling increases resource efficiency and reduces need for landfills. • Waste to landfill charged at full cost so as to generate a new fiscal revenue stream.

6. Prerequisites for scaling and accelerating climate-resilient development in African cities

African leaders increasingly understand the benefits of a low-carbon economy, but continue to struggle with the practicalities of the transition that would enable these benefits without incurring catastrophic fiscal and political risks. How to institutionalise ambitious climate-resilient urban development on the African continent remains the critical question, and has to be answered with full cognisance of the prevailing institutional landscape. Too many normative prescriptions fail to appreciate the limits of African cities' fiscal and spatial planning and governance capacity, and underestimate the degree of political contestation and contingency that prevails in African cities. There is also a disregard for regional differences and the varied manner in which national and local governments interact in Africa. The implicit suggestion in "twin-city" arrangements that Algiers should adopt the same transport plan as Amsterdam, that Lagos might learn from Atlanta's approach to congestion or that Cape Town should adopt Malmo's approach to energy cogeneration, is blind to the very different legal, economic and political contexts in which these cities operate.

In pioneer countries such as Denmark and Germany, popular support for the green economy was secured by public-minded local authorities, the co-operative local ownership of renewable energy utilities, and the provision of public goods such as basic service infrastructure, protected green-open space and enforced planning guidelines. This type of far-sighted planning and

governance capacity is not a strong feature of Africa's local governments – whether municipalities or traditional authorities – and as yet there is very little political currency, or associated will, attached to environmental concerns in Africa (Bulkeley and Betsill, 2013; Taylor et al., 2014; Jaglin, 2014).

Similarly, expectation that markets (for carbon, risk and ecosystem goods and services, for example) will generate the types of price signals that might influence the nature of urban development in favour of climate resilience and competitiveness, needs to be tempered by the fact that few of these markets exist in African cities. This much is evident in the performance of the United Nation's Clean Development Mechanism (CDM) on the African continent; in spite of the obvious need to secure carbon market revenue in Africa and the registration of over 7,000 projects in the developing world, less than 2 per cent of total CDM revenue was secured by African projects (CDM-EB, 2014).

It is necessary to recognise that the current state of African cities does not constitute resilience. Similarly, low CO_2 per capita is not, on its own, an economic advantage. The city of Cape Town, for example, would have to affect a ten-fold increase in the amount of GDP produced per tonne of CO2 emitted in order to comply with the twin goals of poverty alleviation and lower than 2°C warming (own calculation). A definitive transition towards flourishing, low-carbon, climate adaptive cities in Africa would require a radical urban reform – one that would be unthinkable if African cities were not already undergoing a significant transition.

Nonetheless, credible advocates of Africa's urban resilience, need to be specific about the financial, institutional and political processes required to enable the transition to low-carbon growth paths.

6.1 FINANCIAL SUPPORT

Resilient African cities are easily associated with economic benefits, but financing a just transition in order to realise such benefits is more difficult. A significant portion of the $90 trillion that will be invested in developing countries in the next 15 years will be directed to Africa's infrastructure, land use and energy systems (Watkins, 2015). This investment will shape the prospects of the continent. If African cities are to begin harnessing the opportunities created by urbanisation, this investment needs to be trained on the infrastructure deficit ($68 billion – $93 billion per annum), but also reflect accurate information with regard to risks and opportunities. In particular, the investment needs to enable cities to move, in a radical manner, beyond:

- The prevailing high rate of fatal accidents on Africa's roads (32.2 per 100,000 vehicles per annum) and its economic burden.
- The embedded inefficiency, including low levels of distribution and high costs, in Africa's energy utilities.
- Social exclusion and the amplification of existing inequality by the way in which services and economic opportunities are provided.

Since the Industrial Revolution, finance has been a powerful enabler of human progress globally, but has also distributed gains unevenly, caused environmental destruction and has not always sent appropriate signals to investors and savers with regards to long-term, systemic risks (UNEP FI and CISL, 2014). The roles played respectively by credit-rating agencies and international finance and investment, combine to restrict the room for manoeuvre for cities looking to overhaul their expenditure and experiment with the way in which they provide services. Unlike India, China and Brazil, African countries do not have the global economic power to influence the terms of international capital flows in their favour. In addition, the per capita income of Africa's urban population precludes conventional user-pays models for bulk public infrastructure, and many African local governments cannot yet be relied upon to marshal a fiscus, crowd-in private sector investment or raise finance.

Hope that the UNFCCC's Green Climate Fund (intended to provide $100 billion per year in support of climate-resilient development) would address the finance deficit has already been tempered by difficulties in convening a governance consensus for the fund and the slow start in raising the required capital. Furthermore, the history of this type of funding has been associated with supply-driven (as opposed to demand-driven) proposals that are too-often poorly aligned to existing initiatives and local needs.

In spite of the difficulties, financial flows to the continent are increasing, in part due to geo-political shifts in the global economy. China has already extended $5.5 billion worth of oil-backed loans to African countries. In early 2015, China agreed to a $132

million loan to a public–private consortium in Tanzania for the building of East Africa's first wind power (50 MW) plant (ESI-Africa, 2015). In South Africa alone private savings amount to $550 billion. The increased flows of finance will not, of their own accord gravitate towards public goods with low liquidity, long-term pay-backs and high degrees of novelty. As economic growth creates effective demand for finance, and international finance systems improve their reach on the African continent, it is important to recognise that finance is simply a means to an end. The issuing of Johannesburg's "green bond" in 2014 – worth ZAR1.46 billion – was globally celebrated, but the more difficult task will be to spend this money well in support of service delivery, social inclusion and the capacity to service the debt and this is true for all raised finance, equity and grants. An immediate challenge for African cities involves marshalling the flows of investment that they are beginning to attract. The ability to "crowd-in" private finance for public infrastructure is not a common feature of local authorities in Africa. However, by rationing the provision of public services (such as bulk sanitation, waste collection and electricity) to land that is released for housing development, for example, developers will be forced to consider investment in biodigesters, local energy co-generation and on-site waste handling.

As the supply barriers to investing in Africa are removed, the creation of people who can negotiate with private finance institutions on behalf of the public good are likely to be more effective than establishing bespoke "green funds", complete with high transaction costs and risks of moral hazards (WCPG, 2014).

It is also important to recognise that not all climate-smart interventions cost additional money. In the City of Cape Town three categories of green economy options were identified with an initial emphasis on those that either saved money or presented clear paybacks (Savage and Cartwright, 2013):

i. Options that "reduced fiscal expenditure" while either contributing to growth or reducing environmental risk. Examples of these budget-saving projects included discontinuing the full-subsidisation of parking for city officials in favour for partial subsidisation of public transport, replacement of make-shift "porta-loos", leased on expensive monthly contracts, with permanent composting toilets, electricity demand-side management in public buildings via (for example) the disconnecting of the hot-water geyser and the use of LED lights.

ii. Options that did require a fiscal outlay, but "recouped the investment through downstream savings or enhanced growth" while either contributing to growth or reducing environmental risk. Examples include the plugging of leaks in the reticulated water supply, installation of LED traffic lights and the construction of a waste to energy programme. For this category the challenge is affordable finance.

iii. Options that offered little prospect of breaking-even, but yielded the types of co-benefits that render it worthwhile; public transport, protection of endemic biodiversity and incentivised feed-in of small-scale renewable energy for example. In this category, the critical consideration was who benefits from the co-benefits and how the burden of the cost can be shared between the public and private sector.

Financial constraints can be further addressed by consideration of the ability of local communities to provide funding for services that satisfy their basic needs in ways that they feel are valuable. Poor communities pay more (in nominal terms) for potable water and energy than affluent communities. Previously this was true for fixed-lined telephony, but the rapid uptake of mobile telephones in African cities has demonstrated the ability of poor urban people to marshal their finances when a genuinely better option arrives. The benchmark example in this regard is provided by the transition to renewable energy in Denmark and Germany, which was driven and owned by energy co-operatives that sourced finance from within their ranks. The result was local ownership of energy utilities and services that were brought on-stream more quickly and cheaply than state or multinational-owned mega-projects. Household income and social cohesion is higher in Denmark and Germany than in African cities, but where the model is adapted it would ensure that the type of climate-smart services delivered were aligned to local needs, commensurate with the local capacity to pay for and maintain these services and accountable to the intended beneficiaries.

6.2 INSTITUTIONAL SUPPORT

Much of the advocacy for climate resilient African cities correctly emphasises the need for long-term planning and strengthened governance. Joan Clos, for example, points out, "Good cities do not come about by accident. The prerequisites for a good city are broad community consensus, long-standing political determination and sound urban planning … [they] provide wellbeing and security to their inhabitants, guarantee the supply of water, energy and food, and promote a compact and diverse urban

structure in which innovation, trade and economic prosperity are encouraged …. results like these have never been achieved through spontaneous urbanisation, nor by the adoption of wrong-sighted decisions." (Clos, 2014, p.5)

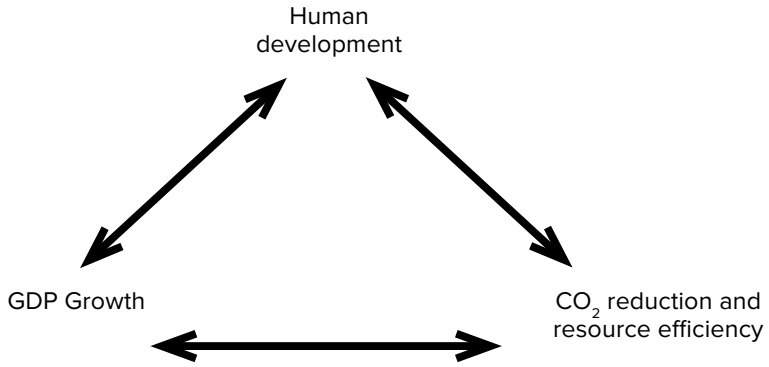
Few African cities, however, are governed by a single, elected authority exercising economic control and supplying uniform services in a planned manner. On the contrary, much about Africa's recent urbanisation challenges the very definition of a city as a place with self-identifying urban residents, clear boundaries and a single authority (Oviasuyi et al., 2010). Even in the exceptions, such as South Africa and Rwanda, control of the all-important energy and tax regime resides with national government, and local governments continue to struggle for legitimacy.

The assumption that African cities will automatically cohere and "modernize" in order to realise opportunities is inappropriate (Jaglin, 2014), and as such, most local authorities in Africa have limited ability to apply the planning instruments that are frequently prescribed for influencing spatial form, energy mix, resource metabolism and mobility. Instead Jaglin points to, "The vitality and multiplicity of actual delivery systems" as the best hope for service delivery in Global South cities. Jaglin's observation does not reduce the need for some form of integrated spatial planning and transformative bulk energy, public transport, road and water infrastructure (Parnell, 2015), but instead points to importance of institutional hybrids as the most likely form of urban governance in developing countries. The composition of these hybrids will vary greatly depending on location, but in a stylised sense will be composed of:

- **Local authorities:** Technological innovation and shifting consumer patterns will not, on their own, be sufficient. Local authorities, whether traditional or elected, have an important role to play in the provision of public goods, in the taxing of the middle-class and in the prevention of catastrophic environmental and social externalities. The progressive devolution of decision making, planning and fiscal power to representative local authorities is an important component of the transition towards climate-resilient cities.
- **Social networks:** In the service-delivery vacuum left by local governments there has been a mobilisation amongst community-based organisations, social entrepreneurs, NGOs and households to provide services and address problems. Supported by technological innovation – including wireless telecoms – these actors are increasingly connected and resourceful. For example, urban Africans are amongst the most energy-aware and energy-literate people in the world due to their need to rationalise the available resource. Transitioning to climate resilience requires governments at various levels not to be threatened by these groups, but to recognise their contributions and find ways of supporting and strengthening their efforts. Protecting the full range of energy and mobility options available to these groups from the anti-competitive habits of the fossil-fuel industry keen to lock their consumption habits into long-term bulk infrastructure and service delivery is a first priority.
- **National governments:** While Africa's leaders may not adopt climate-change mitigation as an organising principle, they have the rare opportunity to take bulk infrastructure decisions in full cognisance of climate-change impacts. Decarbonising the supply of utility-scale energy (predominantly through a shift to hydro-power, geothermal, solar and wind energy) and power-sharing agreements between Africa's regions represents a strategic priority for reasons of climate change, cost and local economic development and employment creation. This potential can only be realised by national governments. National and regional governments have an important role to play in compiling the infrastructure master plans required by the finance community. In some instances, trans-boundary projects are necessary to create the scale for bankable utility projects and to balance the supply and demand of energy through trans-boundary trades within existing power pools. The choices made by national governments will have long-lived influences on city economies (Stafford Smith et al., 2011).

Combining the best of grassroots livelihood approaches with city-scale initiatives and transformative national projects represents the most viable means of obviating the prevailing institutional impediments to Africa's urban development. The ability to support the emergence of hybrids that neither undermine governance, nor crowd-out local initiative and private sector investment, represents an important shift that international agencies need to support. In Ethiopia, for example, the national government created the Ethiopian Electric Utility as an independent body to procure electricity from both the incumbent state-owned Ethiopian Electric Power (EEP) and independent power producers that include private companies and urban authorities. Grid electricity has been procured from new independent power producers and EEP in a step that ameliorates fiscal constraints and sees energy being produced closer to demand. At the same time, smaller energy companies (and NGOs) selling micro-PV units, solar water heaters and energy-efficient cook-stoves have been encouraged so as to decouple urban demand from utility-scale supply.

Figure 14
Development priorities and associated pathways for African cities



Source: Pieterse, 2011.

Identifying which opportunities are best suited to opportunistic livelihood approaches (waste-picking, ecological restoration for flood protection and energy efficiency) and which present natural economies of scale and require top-down co-ordination (spatial planning, decarbonising utilities, mini-grid integration and public transport) is an important component of this capacity. So too is the ability to recognise the varied needs of different African cities. The NCE characterisation of 5 types of African cities based on population and income – "Medium and Large Middle Income Cities", "Middle Income Megacities", "Small Middle Income Cities", "Least Developed Cities" and "Others" (High Income Cities) – points to important distinctions on the African continent. Recognising these distinctions assists in prioritising development priorities. Pieterse (2011) provides a complementary typology highlighting the relative importance of economic growth, human development and resource efficiency (including greenhouse-gas mitigation) as a means of identifying the required transition pathway and governance focus (see Figure 14). Most African cities are pre-occupied with GDP growth, but ensuring that this growth is both inclusive and resilient may provide the most tenable way of sustaining it.

Table 5
Socio-technological options available when creating institutional hybrids in Africa cities

	Local	Network	National and regional
Energy provision	Smart-grids, subsidies for demand-side management, cogeneration and waste to energy, building regulations, extension of access, retrofitting public buildings	Off-grid micro-energy (solar, biogas), efficient biomass stoves, community grids, bilateral power-sharing with industry	Integrated energy planning involving coal, hydro, gas, liquid fuel, renewables and demand-side management. Increased supply, decarbonising utilities, better-integrated regional power pools, reduced transmission losses, implementing policies that prevent anti-competitive behaviour from multinational hydro-carbon companies so as to allow new renewable entrants
Carbon mitigation	Vehicle taxes, parking restrictions, spatial form, clinker content of building material	Informal carbon market linked to local projects	National carbon tax, regional carbon-trading schemes, border adjustment tariffs for carbon

Water and sanitation	Water treatments and sanitation, effective water pricing, biodigesters for purification, preservation of wetlands, rainwater harvesting, greywater recycling, composting toilets and showers	Hand-held and community water purification, bio-centres, community-run biodigesters and biogas projects, permeable paving, aquifer recharging	New dams (linked to energy), inter-basin transfers, trans-boundary water-sharing agreements
Waste management	User-pays waste charges, demarcation of space for recycling, biodigesters, upcycling, composting	Waste-picking and recycling, school programmes, waste-to-energy	Packaging legislation, hazardous waste legislation, waste transport legislation
Mobility	Densification, dedicated mass transport lanes, connecting pedestrians with retailers, vehicle parking restrictions, secure bicycle parking facilities	Taxis, car-pooling, ICT and virtual business, motor/bicycle delivery services, electric bicycle facilities, bike share schemes, BRT system	Inter-city connections, regional transport hubs, rail-freight, fuel-quality control

6.3 POLITICAL SUPPORT

In most African countries, responsibility for energy, infrastructure, transport, environmental protection, water supply and coastal management resides with national agencies. A key requirement for low-carbon, resilient cities, then, involves devolution of control to local government and communities, with national agencies enfranchising local decision makers and investors. Necessarily this devolution needs to be accompanied by local capacitation. For a start, national economic development strategies need to reflect the urbanisation trend and the centrality of cities to their economic prospects and political stability.

There is a conspicuous lack of "green parties" on the African continent (Taylor et al., 2014; Parnell, 2015). This vacuum is attributed to the perception that climate-change responses are a "luxury", something that can be attended to once more pressing priorities of housing, food security and employment creation have been addressed. That climate-change responses can be central to providing basic needs is not a notion that has yet found widespread political traction on the African continent. Political support for a progressive climate-change agenda focused on urban services was behind the international acclaim generated by the South American towns of Curitiba and Bogota's public transport systems. Similarly, Accra attracted attention by emerging at the top of Siemen's Green City Index for Africa, while the Municipality of eThekwini (Durban), led by a small team of committed municipal officials, has secured international funding and recognition (including the right to host COP17) for its climate change efforts. Peru, a country that contributes less than 0.1 per cent to global emissions, has, unlike some African countries, not waited for climate finance and assistance and instead has aggressively embraced low-carbon development as a means of raising its profile and repositioning itself in the global economy.

A political opportunity awaits African leaders who can link climate change and environmental health to basic needs, service provision and the creation of work (Bulkeley and Betsill, 2013). Africa's cities, are the loci of service delivery and as such are the most likely source of popular green political support on the continent.

6.4 NEW KNOWLEDGE

Urbanisation in Africa has been associated with higher rates of school completion and has concentrated existing human capital. In many instances, however, the knowledge and skills required to affect Africa's urban transition do not yet exist (Watson, 2014). Certainly, there is a dearth of documented precedents for how the notions of "better growth", "better climates" and "better cities" take root and become self-enforcing on the African continent. It is not simply a case of applying city ordinances and economic growth models that have proven useful in Europe or Asia.

As yet there is a very poor data set and evidence base from which to construct alternative models. Addressing this requires the strengthening of tertiary learning institutions and novel, long-standing knowledge partnerships between public agencies, private companies and academic institutions. The implications of the knowledge deficit are most acute where the need to address climate change and environmental degradation is seemingly at odds with short-term needs for food, energy,

infrastructure and economic opportunities (Dikeni, 2012; Collier, 2013). Unless a deep understanding of everyday African urbanism is better articulated and allowed to inform the international discourse, prescribed policy models will continuously fail. Efforts are underway to breach the deficit (Watson, 2014), but there remains a particular need to document co-benefits, economic multipliers and development pathways at the urban scale in Africa if the virtuous cycles generated by good governance, public transport, healthier water resources and clean energy are to be more legible to international finance and to the development community.

The emerging knowledge needs to inform the terms of international trade, the flow of funding and the focus of innovation. Where it does, Africa's urban challenges may offer the global economy new precedents (Parnell and Robinson, 2012; Robinson, 2014). Given the small size of African economies, the ability to turn the relative under-development of African cities, complete with low levels of mobility, low per capita carbon emissions and low levels of resource consumption into an economic advantage is only feasible in the context of global economic reforms. Such reforms would need to penetrate trade legislation, competition policy, public-sector subsidies and the financial sector so as to reward Africa's urban economies for pursuing long-term, sustainable alternatives to the default of OECD industrial development that is currently incentivised.[21]

7. Conclusion and implications for decision makers

The expansion of cities in Africa will be a major factor in the success of the post-2015 United Nations development agenda. Building low-carbon, resilient cities, is cheaper than attempting to "green" cities retrospectively and in Africa's rapidly expanding urban centres it may also be cheaper and more beneficial than building cities using conventional infrastructure and service-delivery technologies. This is the strategic opportunity created by this period in the global response to climate change.

Africa's urbanisation trend appears, at first glance, to compound the climate dilemma through the aggregation of urban risks and an acceleration of emissions (Satterthwaite, 2008; World Bank, 2010; IPCC, 2014). But Africa's urbanisation defies convention in a number of structural ways. That so much of Africa's urban environment is yet to be built and serviced creates the opportunity to decouple urban development from emissions and to anticipate climate-change risks and the impact of carbon constraints on global markets. Realising this opportunity in African cities is supported by unprecedented access to clean technology and information, and the continent's recent economic growth.

Africa's cities need not be associated with increased emissions and the amplification of climate risks (LSE Cities, 2012; WRI, 2013). On the contrary, the need to respond to climate change in African cities could provide the impetus, technology and finance with which to craft more viable urban-development pathways that provide basic services and poverty alleviation in spite of the prevailing fiscal and governance constraints. The examples documented in this study suggest that this might be the most plausible way of delivering services and ensuring economic competitiveness in the context of Africa's urbanisation.

Realising this potential is globally important. Individually, the sample of projects described in this report amounts to little, even running the risk of vanity-projects, some of which attract media attention incommensurate with their merit. Collectively, however, they reflect the potential contained in an alternative approach to urban development, one that links an "urban dividend" (Pieterse, 2013) and a "resilience dividend" (Rodin, 2014) through the provision of locally co-ordinated, low-carbon public services and compact urban forms. The central elements of this service provision opportunity include:

- **Energy:**
  Allowing the ongoing energy technology revolution (most notably photovoltaic, storage and lighting) to fulfil its urban potential for reducing demand for utility-scale electricity and for creating local employment. This goal would be supported by protecting the urban energy sector from anti-competitive behaviour by incumbent utilities, de-carbonising energy utilities and drawing on integrated power pools. Reducing the fiscal burden of this priority by recognising the role of independent power producers is critical in the African context. The pursuit of gas-fired electricity needs to keep the long-term goal of locally managed electricity grids powered by multiple renewable feedstocks in mind and ensure that the infrastructure built for gas is compatible with renewable energy.

- **Spatial form, housing and infrastructure:**
  Compact urban forms provide the template for financially viable public services, social inclusion and energy efficiency (including transport energy). Compact urban forms are best achieved with catalytic bulk transport, sanitation and energy infrastructure and via the alignment spatial plans with public sector investment.

Recognising the services provided by the natural environment and ensuring an alignment of ecological and built infrastructure can saves costs, makes for better services and create the type of local, low-skilled work that unemployed urban people can do.

Recognising that "informal" dwellings and economic activity will be a persistent feature of African cities for the coming decades requires the design and enforcement (or incentivising) of softer forms of regulation that do not criminalise all informal settlers and workers but set realistic safety standards and encourage incremental upgrading efforts. Service provision that combines the existing efforts of waste pickers, energy entrepreneurs and public transport operators in "informal settlements", with more formal services tends to be the most cost-effective.

- **Transport:**
  Encouraging Africa's urban commuters into non-motorised modes of transport by creating safe spaces for non-motorised transport, providing accessible public transport that services pedestrianized urban areas, has been shown to save the local economy money and avoids negative pollution and safety externalities.

  Creating the road space for mass transport vehicles and applying transport planning to influence spatial form represents a crucial mobility strategy. Doing this in a way that connects commuters with inner-city retailers and workplaces in safe pedestrian spaces supports local economic development.

- **Water and sanitation:**
  Recent innovation has created new options for water and sanitation provision that do not require the same bulk infrastructure, energy or quantum of water. These options can be delivered in conjunction with local community initiatives, and are essential in the formation of positive urban identities and improved public health.

What these urban services have in common is the ability to meet basic human needs, the ability to draw on new and increasingly affordable technologies many of which create local employment, and the ability to generate virtuous cycles of work, mobility, energy, health and income at the local scale. Cities that are able to deliver low-carbon services in this way will avoid debilitating financial and biophysical risks, generate opportunities that lead to new economic competitiveness and demonstrate leadership in the form of an alternative urban development pathway. It is the fiscal and practical tenability, combined with new economic opportunities, that makes this mode of urban development attractive in Africa's cities. But compact, cohesive and connected African cities will also provide significant public benefit by reducing the carbon intensity of the continent's economic growth (Stafford Smith et al., 2011; Rode and Floater, 2014; Parnell, 2015). Without these interventions, the total emissions from Sub-Saharan Africa's 69 largest cities would increase by an estimated 61 per cent between 2012 and 2030 (Godfrey and Zhao, 2014).

Given the global and local significance of Africa's urbanisation, a critical first step involves recognising the importance of Africa's cities in national economic strategies, and reflecting this recognition in budget allocations, infrastructure planning and governance structures. The nature of local governance in Africa's cities requires that the delivery of services will necessarily have to rely combinations of street committees, local entrepreneurs, local governments, NGOs, national governments and the private sector. The confluence of global climate change, urbanisation and economic growth offers a rare opportunity to convene this capacity, recognising that its composition will differ across African cities and over time.

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ENDNOTES

1 "Africa Rising" was the cover story of the 3rd December 2013 issue of *The Economist*. This was in stark contrast to the same publication calling Africa the "Hopeless Continent" in May 2010.

2 Definitions of who constitutes the African middle class are contested, with the range referring to individuals earning between $2 and $40 per day.

3 As much as half of the $600 billion that Nigeria has received in oil revenue since 1960 resides in off-shore accounts, and $20 billion worth of oil revenue generated in 2012 alone was unaccounted for by the Nigerian National Petroleum Company (NNPC).

4 These data do not take into account the different degrees of devolution and varying local government mandates across countries.

5 Eko Atlantic, the luxury retail and accommodation island being built on reclaimed land off the coats of Lagos, is the quintessential example, but so too are the growing number of shopping malls and up-market housing estates.

6 Historic contribution can be assessed in different ways, including the following: the cumulative emissions approach weighs all historic emissions equally, regardless of when they occurred. A tonne of CO_2 emitted in 1850 has the same "value" as a tonne of CO_2 emitted in 2015. An alternative approach assesses a country's contribution to increased atmospheric CO_2 concentrations. By taking into account the decay of GHGs over time, this approach estimates a country's share of emissions presently in the atmosphere. A third approach attempts to measure a country's contribution to the increase in global average temperature (approximately 0.6° C, globally, above pre-industrial levels).

7 The IPCC's 2014 report was clear that "Risks are amplified for those lacking essential infrastructure and services or living in poor-quality housing and exposed areas", and that "Risk of mortality and morbidity increase during periods of extreme heat, particularly for vulnerable urban populations."

8 The United Nations leant its support to the divestment campaign in March 2015, saying, Companies will not be allowed to "Burn what they like when they like".

9 The 2°C target has been attached to a global carbon budget of 1 trillion t CO_2, of which the world has already used 580 billion t CO_2.

10 This is required to stabilize atmospheric concentrations of greenhouse gases at 450–500 ppm and have an even chance of limiting warming to 2°C.

11 AgriProtein is a "... nutrient recycling business, and uses urban waste to farm fly larvae that are used to replace fishmeal as a cattle feedstock."

12 North Africa, which has almost 100 per cent formal electricity supply, is similarly dependent on the burning of fossil fuels, but has no nuclear and a slightly higher reliance on wind energy.

13 http://www.financialmail.co.za/features/2014/07/17/renewable-energy-sa-margins-too-tight

14 In South Africa, procuring electricity for peak demand costs $0.55/ kWh whereas base-load costs $0.07. In Tanzania, where peak-demand is supplied with diesel generators, the cost is $0.33/ kWh.

15 The household scale PV revolution in Africa is analogous to the mobile phone revolution that preceded it, in that both were driven by the absence of bulky transmission infrastructure.

16 In early 2015 South Africa's cabinet voted not to pass the tabled Independent Systems Market Operating (ISMO) Act, that would have seen a debundling of the monopoly/monopsony power held by the state-owned utility Eskom, citing needs to ensure energy security in the face of countrywide rolling blackouts. In contrast Ethiopia's national utility (EEPCO) has actively welcomed independent power producers.

17 In Latin America the figure is 100, in Asia 190 and in Europe 60.

18 A bus traveling at 50 km/hour requires 40-fold less road space per commuter than a car at the same speed (Rode and Gipp, 2001).

19 Jan Eliasson is the UN Deputy Secretary General and used these words in opening the 2014 UN Water Week.

20 Le Sueur and Another v Ethekwini Municipality and Others (9714/11) [2013] ZAKZPHC 6 (30 January 2013).

21 The Conference on Financing for Development, to be hosted in July 2015 in Addis Ababa, represents an important opportunity for financial-sector reform so as to insist that the sector sends more accurate signals to investors and savers regarding long-term risks and opportunities.

ABOUT THE NEW CLIMATE ECONOMY

The Global Commission on the Economy and Climate is a major new international initiative to examine the economic benefits and costs of acting on climate change. Chaired by former President of Mexico Felipe Calderón, the Commission comprises former heads of government and finance ministers, and leaders in the fields of economics, business and finance.

The New Climate Economy (NCE) is the Commission's flagship project. It provides independent and authoritative evidence on the relationship between actions which can strengthen economic performance and those which reduce the risk of climate change. It reported in September 2014 in advance of the UN Climate Summit. It aims to influence global debate about the future of economic growth and climate action.

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AFRICAN CENTRE FOR CITIES
urbanism from an african perspective

The African Centre for Cities (ACC) is an interdisciplinary research and teaching programme at the University of Cape Town. ACC is focused on quality scholarship regarding the dynamics of unsustainable urbanisation processes in Africa, with an eye on identifying systemic responses.