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Building the future

Infrastructure in Nigeria until 2040

Julia Bello-Schünemann and Alex Porter

Nigeria's basic physical infrastructure deficit severely undermines the country's prospects for economic growth and development. Looking to the future, rapid population growth will compound the challenge of inadequate levels of access to basic infrastructure. On average, Nigeria's African and global income peers have more extensive and better road networks, and better access to electricity, clean water and improved sanitation. Using the International Futures model, this report explores a set of interventions to accelerate Nigeria's infrastructure development and potential benefits for the economy and human development until 2040.

Key points

- Nigeria's basic physical infrastructure deficit severely compromises the country's prospects for economic growth and human development.
- Levels of access to basic infrastructure such as electricity, roads, clean water and improved sanitation facilities have not kept pace with rapid population growth in Nigeria.
- Future levels of access are expected to continue to lag behind average levels of access in both Nigeria's African and global income peers.
- The country's basic infrastructure deficit is most severe in the category of access to improved sanitation.
- Improving access to basic infrastructure such as water and sanitation has historically been overlooked in Nigeria because of a short-sighted economic focus on roads and energy.
- Yet increasing access to improved sanitation has the largest impact on human development outcomes as well as on the size of the economy.

Introduction

Nigeria faces multiple simultaneous pressures to advance economic growth and human development in a context of a large and rapidly growing population.

Presently the greatest drag on Nigeria's economic growth is the country's substantive deficit in basic physical infrastructure,[1] which also severely compromises human development. The World Economic Forum's 2016-17 Global Competitiveness Index ranks Nigeria's infrastructure at the bottom – 132 out of 138 countries[2] – and according to the organisation's 2016 Executive Opinion Survey,[3] the poor supply of infrastructure is also the largest constraint on doing business in the country.

In a similar vein, Nigeria's 2017 Economic Recovery & Growth Plan (ERGP) points to 'deplorable infrastructure'[4] as one of the main factors that 'seriously undermined' economic performance in the past.[5]

Despite some progress over the past decades, levels of access to basic physical infrastructure such as clean water and improved sanitation, electricity and (paved) roads in Nigeria are inadequate given its income levels and its rapidly growing population. Further, access levels tend to be below the average of its African income peers, and Nigeria significantly lags behind most of its global income peers.

> The greatest drag on Nigeria's economic growth is the country's substantive deficit in basic physical infrastructure

Currently only 16% of Nigeria's roads are paved, compared on average to half the roads in the world's lower middle-income countries. Similarly, in 2016, only about 30% of Nigeria's population had access to improved sanitation facilities compared to, on average, more than half of the population in the country's global income peers. The situation for access to clean water and electricity is similar.

The need for change is apparent, and a number of Nigerian policy documents, including the ERGP, acknowledge this and propose various strategies and more or less specific objectives. Further, Nigeria's National Integrated Infrastructure Master Plan (NIIMP), approved in 2015, provides a strategic framework for transformation of the country's weak infrastructure base.[6] Energy and roads tend to be at the forefront of policy and budgetary allocations.

Sector-specific strategies such as the Partnership for Expanded Water Supply, Sanitation and Hygiene (PEWASH) spell out the negative implications of poor infrastructure and low access levels to clean water and improved sanitation on people's health with a focus on rural areas. In June 2017, the federal government inaugurated a technical working group for the development of the first operational plan for the implementation of the NIIMP.[7]

Looking to the future, rising incomes and rapid population growth are bound to significantly increase future demand for infrastructure in Nigeria. Over the next 23 years, Nigeria's population is expected to increase from its current estimate of 190 million people to almost 330 million, representing a more than 70% increase.[8] Without drastic improvements in Nigeria's basic physical infrastructure, this growth will compound the existing deficit.

Prioritising basic physical infrastructure and ensuring that people have access to the associated services is likely to catalyse progress across multiple other systems, in particular the economy, health and education.

Therefore this report focuses on the need to advance access to basic physical infrastructure as a fundamental component of future economic and human development strategies in Nigeria.

Structure of this report

This report first compares access levels to basic physical infrastructure in Nigeria with those in relevant income peers in Africa and globally, and analyses how these are likely to evolve to 2040 along the current development trajectory (referred to here as the Current Path). Moreover, it addresses the question of whether Nigeria's access levels are in fact worse than what could be expected given its income level.

Next, the report explores a series of interventions aimed at improving basic infrastructure in Nigeria over the next 23 years before comparing the benefits of those interventions for the economy and for human development. A scenario that combines the individual interventions representing an 'integrated push' for access to basic infrastructure will also be explored. Lastly, the report models an intervention that simulates a faster reduction in fertility rates – and hence slower population growth than is expected on the Current Path.

Methodology

There is no single definition of infrastructure, but broadly, physical infrastructure includes four main categories: transportation, energy, water and sanitation, and information and communication technologies (ICT).[9]

This report uses the International Futures forecasting system (IFs) (see Box 2) to explore Nigeria's likely infrastructure trajectory (Current Path) across the categories of access to clean water and improved sanitation (see Box 1 for definitions), access to electricity, road density per land area and share of paved roads until 2040. With the exception of roads, access to infrastructure is used as a proxy for the extent and sophistication of infrastructure in Nigeria.

These forms of infrastructure are the most fundamental, and they have clear and empirically established links with human development and economic growth. Moreover, the available data is of reasonable quality considering the existing constraints. The category of information and communication technology is beyond the scope of this report.[10]

Box 1: Definition of safe water and improved sanitation

Safe water

The Joint Monitoring Programme (JMP) of the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF) defines safe water as water that comes from either shared or private improved drinking water sources. An 'improved' source of drinking water is 'one that by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly faecal matter'.[11] This includes piped water, wells, boreholes and natural water sources that are adequately protected from environmental contaminants.[12] This report uses the term 'clean water' when referring to water access.

Improved sanitation

Access to improved sanitation, as defined by the JMP, is more limited than water because it excludes shared facilities. The JMP defines an adequate or 'improved' sanitation facility as one 'that hygienically separates human excreta from human contact'.[13] This includes a flush toilet, connection to a piped sewer system, connection to a septic system, flush or pour-flush to a pit latrine, pit latrine with slab, ventilated improved pit latrine or composting toilet. This paper uses the term 'improved' when referring to sanitation access.

Source: Alanna Markle and Zachary Donnenfeld, Refreshing Africa's future: prospects for achieving universal WASH access by 2030.[14]

Box 2: International Futures (IFs)[15]

IFs is a long-term integrated modelling system that leverages historical data (over 4 000 series) to identify trends and forecast hundreds of variables for 186 countries for every year from 2015 to 2100. There are three main avenues for analysis in IFs: historical data analysis (how systems have developed thus far), Current Path analysis (where systems seem to be heading given current policies and environmental conditions), and alternative scenario development (exploring if-then statements about the future). IFs provides forward-looking, policy-relevant analysis that frames uncertainty around the future of countries (or groups of countries) and across development systems. It also helps users to think systematically about potential futures, as well as development goals and targets.

The IFs Current Path or Base Case is a collection of historical data and trends that represent a likely scenario of how the future will unfold. The Current Path or Base Case assumes no major paradigm shifts, policy changes or 'black swans' (extremely low-probability but high-impact events). Although the Current Path generally demonstrates continuity with historical patterns, it provides a structure that moves beyond a simple linear extrapolation of previous trends.

Because the IFs model draws from global trends and data sources and forecasts across over 500 variables across 186 countries, country-level data and forecasts are often adjusted to better reflect country-specific trends and conditions. For this paper, the IFs Current Path was adjusted along four dimensions – road density, paved road density, gas production and oil production – to better reflect current environmental and policy conditions. The Current Path forecasts for road density and percentage of paved roads were reduced by about 9% and 15% respectively, and the forecasts for oil and gas production were adjusted down to better reflect current production trends.[16]

Nigeria is a lower middle-income economy as per the World Bank classification.[17] In this report Nigeria's infrastructure access levels are benchmarked against access levels of other lower middle-income economies in Africa (African income peers) as well as lower middle-income economies globally (global income peers), specifically Pakistan, India and Indonesia (see Table 1).

By benchmarking Nigeria to these three countries that currently all rank higher on the United Nations Development Programme's (UNDP) Human Development Index (HDI) than Nigeria (see Table 2), this report opts for an aspirational approach to where the country should be given the size of its economy, its resource richness and its population size. With an estimated population of more than 190 million in 2017, Nigeria is the seventh most populous nation in the world. According to a previous ISS report, it is also the only country in sub-Saharan Africa that has the potential to be a significant player globally in terms of its material capabilities.[18]

Table 1: Nigeria's African and global income peers

African income peers	Cameroon, Cape Verde, Republic of the Congo, Ivory Coast, Djibouti, Egypt, Ghana, Kenya, Lesotho, Mauritania, Morocco, São Tomé and Príncipe, Sudan, Swaziland, Tunisia and Zambia
Global income peers	Armenia, Bangladesh, Bhutan, Bolivia, Cambodia, El Salvador, Guatemala, Honduras, India, Indonesia, Kosovo, Kyrgyz, Laos, Federal States of Micronesia, Moldova, Mongolia, Myanmar, Nicaragua, Pakistan, Palestine, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Syria, Tajikistan, Timor-Leste, Tonga, Ukraine, Uzbekistan, Vanuatu, Vietnam and Yemen

Apart from their classification as lower middle-income economies, Pakistan, India and Indonesia are generally comparable to Nigeria in terms of population size, land area, population density and levels of urbanisation (see Table 2). The modelling in this report uses the history of improvements in infrastructure access levels in these countries as a reference to think about ambitious yet realistic targets for Nigeria (see Table 5).

Table 2: Select indicators for Nigeria and comparison countries (2016 values)

Country	Population (millions)	Population density (people per hectare)	Land area (km^2)	Percentage of people living in urban areas	GDP per capita (PPP) (thousand USD)[19]	GDP per capita (MER) (thousand USD)	HDI rank
India	1 327.0	4.5	297.3	42.0	6.0	3.9	131
Indonesia	260.6	1.4	181.2	54.6	10.6	4.4	113
Nigeria	186.7	2.1	91.1	49.1	5.3	2.7	152
Pakistan	192.6	2.5	77.1	39.1	4.8	1.4	147

Source: IFs v 7.29, historical data from UNPD, World Development Indicators, UN World Urbanization Prospects.

Why infrastructure matters

William Ascher and Corinne Krupp describe physical infrastructure as 'the backbone of any developed economy and a pillar of quality of life'.[20]

The 2030 Agenda for Sustainable Development dedicates several goals to infrastructure development, thereby recognising its crosscutting nature and its fundamental importance for human progress. Specifically, Goal 6 addresses the need for clean water and sanitation for all;[21] Goal 7 tackles the need for universal access to affordable, reliable and modern energy services; and Goal 9 focuses on building resilient infrastructure,[22] promoting sustainable industrialisation and fostering innovation.[23]

The extent and sophistication of infrastructure matters hugely for both economic growth and human development. Scholars agree that the net impact of infrastructure development on the economy is 'positive and significant'.[24] Calestous Juma argues that sub-Saharan Africa's lack of structural economic transformation and its weak integration into the global economy is at least partly a reflection of 'inadequate investment and development of infrastructure'.[25]

Improvements in roads, reliable and cost-efficient electricity supply and ICT and increased access to these types of infrastructures directly and predominantly increase physical as well as technological and business capital. Such improvements boost economic activity and demands for goods and services, create jobs in the short to medium term, and make economies more competitive. In fact, infrastructure is one of the key categories in the World Economic Forum's yearly Global Competitiveness Report.

>190 million

THE ESTIMATED POPULATION OF NIGERIA IN 2017

Good infrastructure mitigates the impact of distance and so serves to integrate the national market and to facilitate trade with other countries and regions.[26] 'Good quality roads and railways, for example, make it easier, cheaper and faster to transport goods and people, while airports and seaports connect firms across international boundaries, facilitating trade and investment,' according to the Global Infrastructure Outlook.[27]

On the other hand, improved water and sanitation infrastructure drives human capital via its impact on health, education, equality and empowerment, all fundamental components of economic productivity and growth. According to the World Bank's Water and Sanitation Programme, on average, poor sanitation infrastructure costs countries approximately 2.8% of GDP per year.[28]

> Children who don't have access to clean water, improved sanitation facilities or electricity are more likely to contract a communicable disease

Expanded access to clean water and improved sanitation is key to improving health outcomes across the population, in particular to prevent the spread of communicable diseases, such as cholera, diarrhoea, typhoid, hepatitis A, polio, etc. Children who don't have access to clean water, improved sanitation facilities or electricity are more likely to contract a communicable disease, which can impair their ability to fully develop physically and mentally and can negatively impact their productivity later in life. Poor sanitation also contributes to malnutrition, which in turn compromises educational achievements.

Open defaecation, a by-product of the lack of adequate sanitation infrastructure, perpetuates a vicious cycle of disease and poverty. The countries where open defaecation is most widespread are characterised by the highest number of deaths of children aged under five years as well as the highest levels of malnutrition and poverty, and major income inequality.[29]

The provision of electricity infrastructure, on the other hand, also has direct implications for health as it can help reduce dependence on traditional cookstoves which are associated with respiratory infections in children and respiratory diseases in adults.[30] Further, higher access to (affordable) electricity improves educational outcomes and is generally associated with increases in female employment rates.[31]

Lastly, access levels to infrastructure also affect income inequalities, marginalisation and poverty. Without adequate transport and communications infrastructure, poorer communities cannot access core economic activities and services, such as healthcare and education.[32]

In Nigeria's case, the lopsidedness and perceived inequity in the distribution of infrastructure remains one of the drivers of regional agitations and political instability. The relatively more advanced infrastructure in cities like Abuja and Lagos, respectively Nigeria's political and economic capital cities, is often

IN AFRICA, NIGERIA RANKS

32 out of 54 countries

ON THE IFS TRADITIONAL INFRASTRUCTURE INDEX

Figure 1: Earth lights from space

Source: Image courtesy of the NASA Visible Earth Project.[33]

cited as one of the motivations for militants and political agitators in several of Nigeria's conflict-affected areas like the Niger Delta (Movement for the Emancipation of the Niger Delta), the north-east (Boko Haram) and more recently the south-east (Indigenous People of Biafra).

Nigeria's infrastructure deficit and the Current Path

In 2016, Nigeria had one of the lowest levels of access to improved basic infrastructure anywhere in the world, ranking 162 out of 186 countries, according to the IFs traditional infrastructure index.[34]

In Africa, Nigeria ranks 32 out of 54 countries, and among its global lower middle-income peers only Sudan and Papua New Guinea perform worse. On the current development trajectory, by 2040 Nigeria is expected to still rank only second-last in this group.

Box 3: Infrastructure and agriculture

Poor infrastructure – especially lack of roads, electricity supply, irrigation and storage facilities – also undermines agricultural productivity, a sector of vital and increasing importance for the Nigerian economy and for food security in the country.[35] Without improving rural roads, for example, it will be difficult for farmers to move beyond subsistence farming and access national and international markets with potential surpluses.[36]

Roads reduce transaction costs due to distance and allow for easier transport of inputs, such as fertilisers. 'Transport costs in Africa are often five times higher than in Asia due to the region's poor road networks,' according to Rick Hodges et al.[37] Dale Rothman et al argue that irrigation systems provide water, and reliable access to electricity enables supply systems that prevent crop spoilage and allows for efficient meat and dairy production and distribution.[38]

Box 4: Infrastructure and productivity

Physical infrastructure is directly relevant to economic productivity and economic growth. In IFs, this relationship is operationalised through the use of a multifactor productivity function consisting of physical capital, knowledge capital, social capital and human capital. Infrastructure is a key component of physical capital, along with natural resources.[39] The impact of infrastructure on multifactor productivity in IFs is a function of a composite index of physical infrastructure, which includes both more traditional forms of infrastructure (transportation, electricity, and water and sanitation) and ICT.[40]

According to IFs, physical capital is by far the biggest drag on economic growth in Nigeria. That said, human capital, social capital and knowledge capital all currently represent significant drags on productivity relative to other countries at similar levels of economic development.

Nigeria's infrastructure deficit is evident across all categories as the country performs worse than its average African income peer and significantly worse than its average global income peer (see Figure 2).

On average half of the roads in the world's lower middle-income countries are paved compared to about only 16% in Nigeria. Close to three-quarters of Pakistan's roads and 55% of India's roads are paved. In the category of access to electricity, the gap between Nigeria and its global peers is smaller yet still significant. More than 80% of the population living in the world's lower middle-income countries have access to electricity versus only 60% in Nigeria.

> Nigeria's population growth has not been matched by an increase in the delivery of water supply, sewerage and sanitation services

Nigeria also lags behind both African and global income peers in access to clean water and improved sanitation facilities. In 2016, almost 90% of the population of the world's lower middle-income economies had access to clean water compared to less than 70% of Nigeria's population. In other words, with the exception of a few outliers, most of Nigeria's global income peers are quite close to the SDG target of universal access to clean water.

ONLY

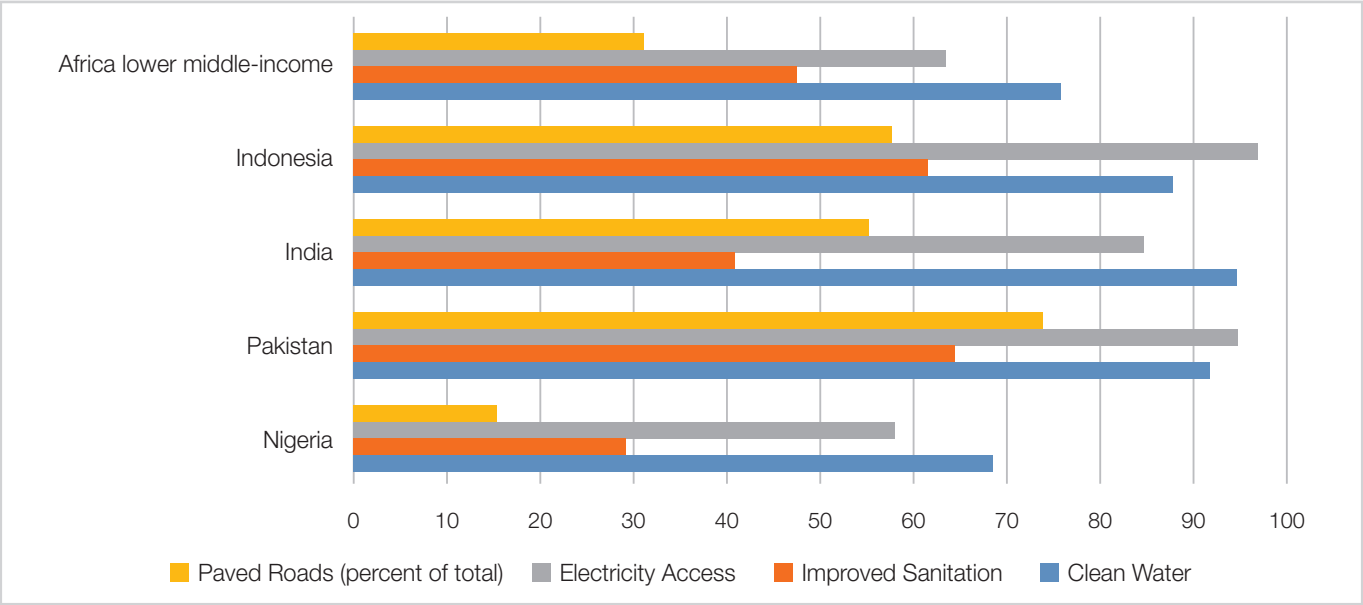
16%

OF NIGERIA'S ROADS ARE PAVED

The discrepancy between Nigeria and its global income peers is worse in the area of access to improved sanitation. Only about 30% of Nigerians have access to improved sanitation facilities compared to, on average, more than 50% in the country's global income peers. Current access levels in Pakistan are more than twice as high as in Nigeria. Essentially, Nigeria's population growth has not been matched by an increase in the delivery of water supply, sewerage and sanitation services.

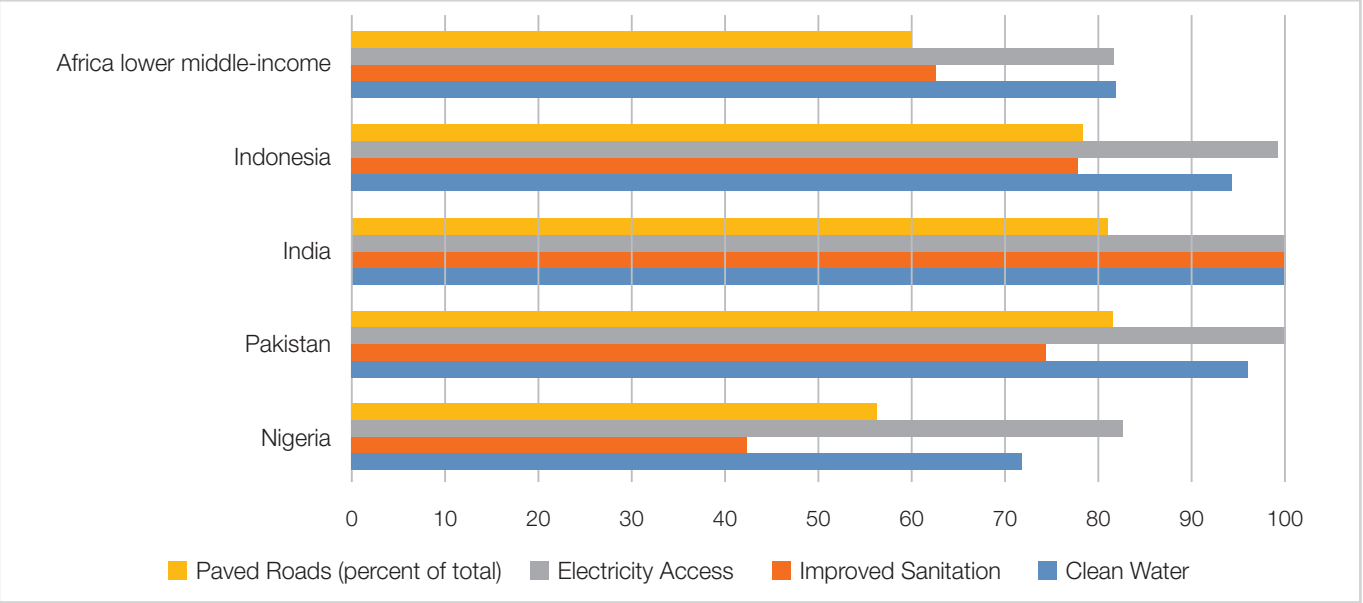
By 2040, the gap between Nigeria's performance and that of its African and global income peers is essentially forecast to remain (see Figure 3).

Figure 2: Levels of access to basic infrastructure (percent of population) in 2016, Nigeria in comparison



Source: IFs v 7.29, data from UNICEF/WHO Joint Monitoring Programme (water and sanitation), International Road Federation (roads) and World Bank (electricity).

Figure 3: Levels of access to basic infrastructure (percentage of population) in 2040, Nigeria in comparison



Source: IFs v 7.20, data from UNICEF/WHO Joint Monitoring Programme (water and sanitation), International Road Federation (roads) and World Bank (electricity).

Continued rapid population growth in the future is going to strain service provision even more and therefore presents a major challenge to government capacity in Nigeria going forward.

Clean water

Nigeria has significantly improved access to clean water over the past 25 years. In 1990, only 40% of Nigerians had access to clean water while the averages for both African lower middle-income countries and global income peers were above 70%.

Much of this progress has come from improving access to public taps, protected wells and springs, and rainwater collection (rather than piped water).

Nigeria has increased the number of people connected to these types of safe water facilities from 26 million in 1990 to 122 million in 2016.

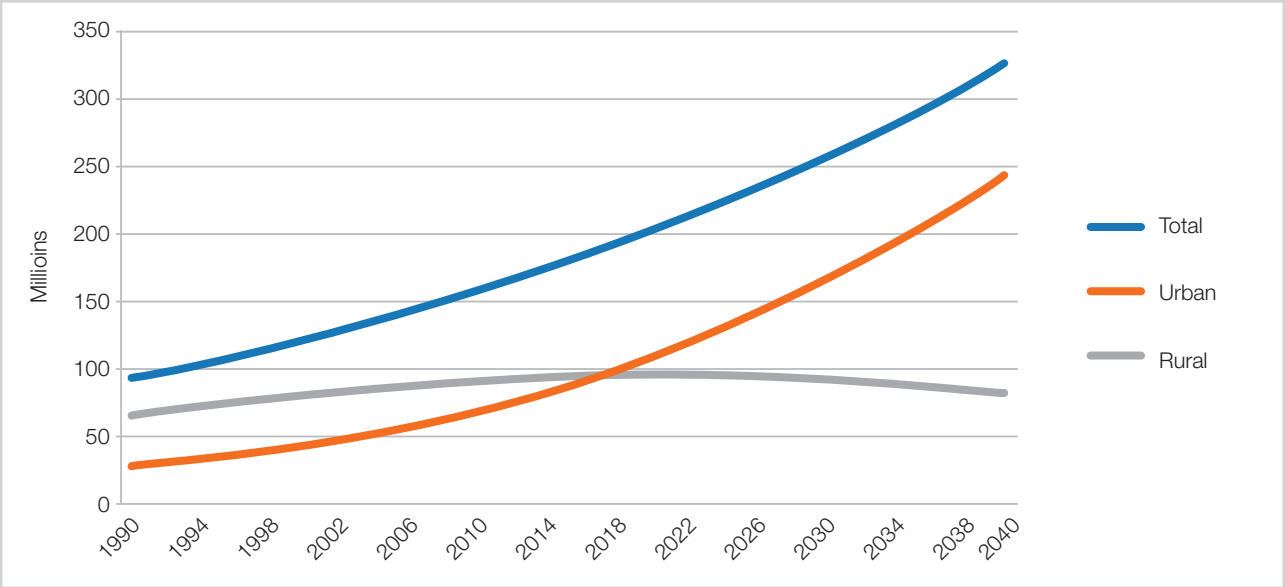
This represents a close to fivefold increase in the number of people with access to improved water sources, and is an impressive achievement for such a large country.

This progress could reflect a general pattern across developing countries, which according to Dale Rothman et al is connected to 'the immediate health implications of unsafe water' but also the 'frequently dispersed availability of sources via streams and wells', which implies that improving access rates often 'requires less public organization and investment than do roads or electricity systems'.[41]

Box 5: Urbanisation

Nigeria's urban population is growing much faster than its rural population. The latter is in fact beginning to decline both in absolute numbers as well as a share of the overall population (see Figure 4).

Figure 4: Nigeria's population growth (total, urban and rural) (million people), history and forecast, 1990-2040



Source: IFs v 7.29, historical data from the UNPD.

With half its population living in urban areas in 2017, Nigeria is significantly more urbanised than its average global and sub-Saharan African income peers. By 2040, close to 75% of Nigeria's population is expected to live in urban areas, which is likely to increase population densities further.

Nigeria is already densely populated by both African and international standards. Some of the country's largest cities, such as Lagos, Kano and Port Harcourt, are notably denser than other cities of comparable population size such as London, Nairobi and Dar es Salaam. In contrast, Nigeria's infrastructure-to-population ratio is very low.[42]

Urbanisation and high population densities present opportunities for infrastructure provision as economies of scale arise in urban areas that can make infrastructure projects more cost-efficient and easier to implement.[43] However, such opportunities can only be seized if there is adequate long-term planning and implementation.

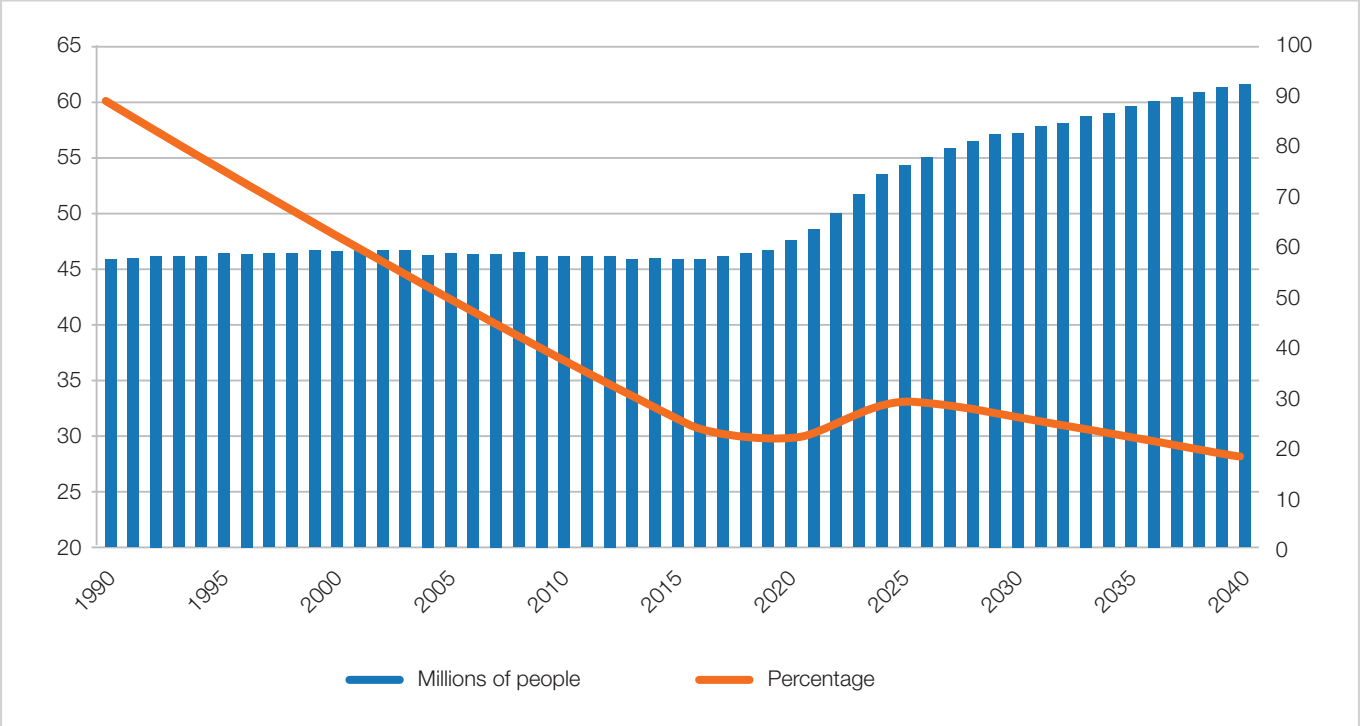
With increasing levels of urbanisation, the type of infrastructure that needs to be prioritised might at least partly shift as well. According to the report From Oil to Cities: Nigeria's Next Transformation, Nigeria requires investment in four critical areas of urban infrastructure: utilities infrastructure, including electricity, water distribution, and sewerage; housing; interregional corridors to reduce economic distance between regions and cities; and mass transport cities to relieve congestion and lower transport costs.[44]

Nonetheless, nearly 60 million people (almost 30% of the population) still do not have access to clean water, and rely on unimproved sources such as unprotected wells, springs and surface water. In 2016, about 70% of the population had access to clean water, which is about 10 percentage points below the average for Africa's lower middle-income countries and more than 20 percentage points below the average for Nigeria's global income peers.[45] Of the overall population with access to clean water, only 2.5% had access to piped water in 2016. The rest had access to shared pumps and spigots, rainwater, etc. By 2040, still only around 16% of the population is expected to have access to piped water.

> Nearly 60 million people still do not have access to clean water, and rely on unimproved sources such as unprotected wells

IFs forecasts that improvements in water access will slow and even decline in the short to medium term, largely due to Nigeria's expected moderate growth prospects due to lower oil prices and continued rapid population growth. While the long-term forecast trends upward, this medium-term slowdown means that Nigeria is only forecast to increase safe water access to 72% by 2040, less than a 5% improvement over a period of more than 20 years (see Figure 5).

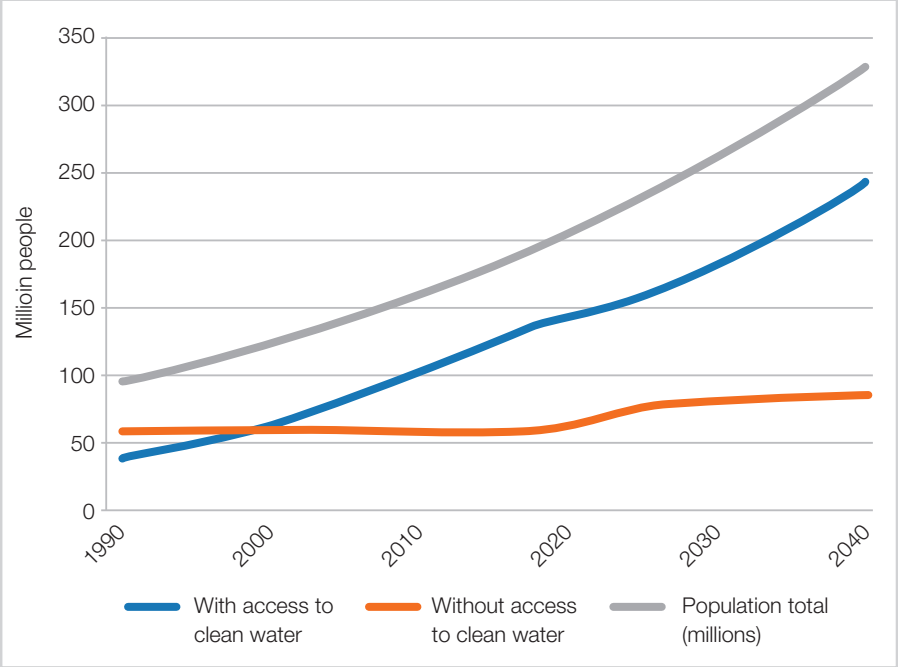
Figure 5: People without access to clean water in millions (bars) and as a percentage of the overall population (line) from 1990 to 2040



Source: IFs v7.29, historical data from UNICEF/WHO Joint Monitoring Programme.

Therefore, even though the absolute number of people with access to safe water is likely to increase from 130 million in 2016 to over 235 million in 2040, over 30 million more people (hence a total of over 90 million people) will be without access to improved water sources by 2040 (see Figure 6). It also means that on the Current Path, Nigeria will miss the SDG goal of universal access to safe water by 2030.

Figure 6: Population with and without access to clean water and population growth (million people), Nigeria, history and forecast



Source: IFs v 7.29, historical data from World Health Organisation (WHO).

Even though in 2016 access levels to clean water were higher in urban than in rural areas (around 80% compared to about 60% respectively), rapid urban population growth has also made it difficult to meet piped water demand in Nigeria's cities. According to a World Bank report, many urban water supply systems suffer from extensive deterioration and poor utilisation of existing capacities due to a lack of maintenance, poor operation and inadequate power supply.[46] In many urban areas people need to buy water from private vendors which is more expensive, and unaffordable for most.[47] The result is that more and more people living in urban areas face water scarcity.[48]

Data on Lagos, Nigeria's largest city with an estimated population of around 15 million people in 2016, points to a story of severe underinvestment in water infrastructure. Less than 60% of the megacity's population enjoys access to clean water. In other words, Lagos performs significantly worse than the average urban area in Nigeria.[49]

Nigeria's public sector is essentially unable to meet the growing demand for water (and sanitation) in the country. Besides poor operation and maintenance, Nigeria's water sector is also characterised by underinvestment,

>85%

THE PERCENTAGE OF LAGOS'S RESIDENTS THAT HAVE ACCESS TO IMPROVED SANITATION

a lack of private-sector participation, weak governance and a lack of policies to enable efficient and sustainable service provision.

There are significant inefficiencies across the three tiers of government that share responsibility for managing the provision of water. The Federal Ministry of Water Resources (FMWR) is responsible for policy formation, data collection, monitoring and coordinating water supply development, and funding research and development. The 36 state water agencies (SWAs) are in charge of the establishment, operation, quality control and maintenance of urban and semi-urban water supply (and sometimes rural). The local government authorities (LGAs) – 774 in total – are responsible for the establishment, operation and maintenance of rural water supply schemes and sanitation facilities in their areas, but most lack the necessary resources and skills, including to construct small water systems such as open wells, etc.[50]

> Less than 60% of the population of Lagos enjoys access to clean water

In 2016 the government published PEWASH, which essentially buys into the SDG target of achieving universal access to clean water by 2030.[51] However, despite the fact that Nigeria is already very urbanised and that the urban population is growing much faster than the rural population, the strategy targets rural areas only.

Improved sanitation

In the category of access to improved sanitation, Nigeria's infrastructure deficit is even more severe. In 2016, over two-thirds of Nigeria's population did not have access to improved sanitation facilities.

Nigeria's access levels are remarkably low in comparison to the average levels in both its African and global income peers. In 2016, close to 60% of the population living in Africa's lower middle-income economies had access to improved sanitation. Access levels for Pakistan and Indonesia in the same year were above 60%, and in India 40% of the population had access to improved sanitation.

Given Nigeria's level of GDP per capita, the share of people with access to improved sanitation should be much higher than it currently is. In fact, despite having a GDP per capita almost five times higher than Malawi, access to improved sanitation facilities is more than 12 percentage points higher in Malawi than in Nigeria.[52]

Over the past decades in Nigeria, access to improved sanitation has deteriorated rather than improved. This is mostly due to rapid population growth, but it is also linked to poor awareness and planning as well as severe and systematic underinvestment.

In 1990, Nigeria had a higher level of access to improved sanitation than its global income peers. Yet since then, the portion of the population with access to improved sanitation has dropped from just under 40% to about 30% today. The country has seen an increase in the number of people with access to improved sanitation by 18 million people, but at the same time there has been a much more rapid increase in the number of those without access to improved sanitation (from 36 million in 1990 to nearly 88 million today) (see Figure 7). In 2016, more people practised open defaecation in Nigeria than in 1990, both in absolute numbers and as a share of the overall population.

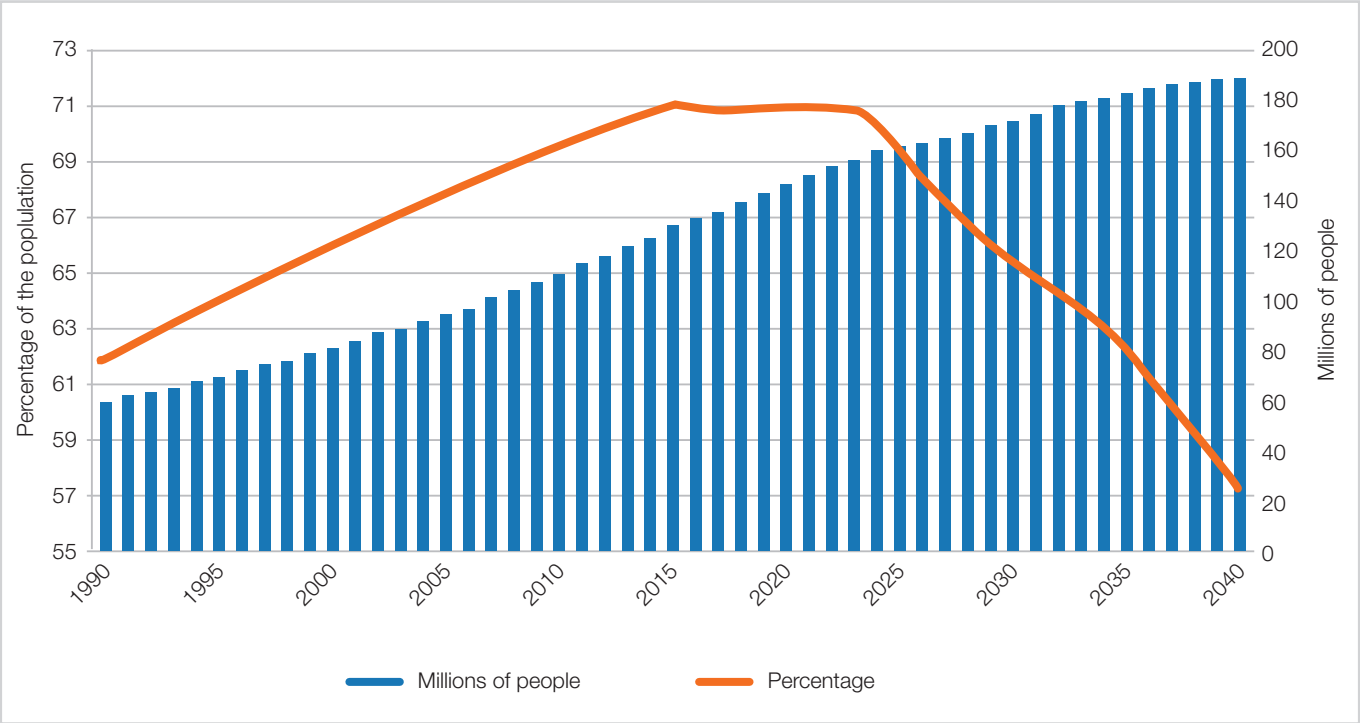
In other words, the provision of sanitation facilities has lagged far behind the needs of a rapidly growing population with the result that Nigeria spectacularly missed the MDG target of reducing the share of the population without access to improved sanitation by 50% between 2000 and 2015.

Sanitation is a state government responsibility, but in practice, sanitation becomes the responsibility of individual households who cannot afford to improve facilities. There are hardly any sewer systems across communities, with the exception of the capital Abuja and some areas of Lagos.[53]

Indeed, access to improved sanitation in Lagos is much better than in the average Nigerian urban area or in rural areas.[54] Over 85% of Lagos's residents have access to improved sanitation[55] compared to close to one-third of Nigeria's overall urban population and only one-quarter of the country's rural population.[56]

Looking to the future, access to improved sanitation is forecast to stagnate for the next few years before steadily increasing out to 2040. Even with a steady increase from 2024 onwards, the portion of those with access to

Figure 7: People without access to improved sanitation in millions (bars) and as a percentage of the overall population (line) from 1990 to 2040



Source: IFs v 7.29.

improved sanitation will only reach 42% by 2040 (see Table 3). This means that 188 million Nigerians are likely to still be without access to sanitation facilities 10 years after the conclusion of the SDGs.

Meanwhile the Current Path forecasts that Pakistan and Indonesia will steadily improve access to 74% and 79% respectively, while India is expected to come close to the SDG targets by rapidly increasing access from 40% today to universal access around 2030.

Table 3: Access to improved sanitation (% of population), Nigeria in comparison, 2016 and 2040[57]

	Improved sanitation (% of the population)	
	2016	2040
Nigeria	29	42
India	41	100
Indonesia	61	78
Pakistan	64	74

Source: IFs v 7.29.

Factors that have constrained progress in the past include a lack of awareness, poor planning, funding constraints, lack of clarity about the roles and responsibilities of the three tiers of government and their agencies involved with sanitation. Moreover, there is a lack of coordination, poor implementation of hygiene and sanitation programmes by different agencies and above all an absence of coherent policies on sanitation.

Low levels of access to clean water and improved sanitation directly contribute to Nigeria's high communicable disease burden and high levels of malnourishment in its overall population. Yet despite the negative implications of poor sanitation on health and human development, sanitation has not been prioritised by the Nigerian government.[58] The PEWASH strategy is an attempt to change this but, as in the case of water, it has an exclusive focus on rural areas.

Electricity access

On access to electricity, Nigeria performs more according to expectations than in the categories of access to water and sanitation. In 2016, almost 58% of Nigerians (close to 106 million people) had access to electricity. Relative

to the country's level of GDP per capita access rates are lower than expected and about 9 percentage points lower than in the average African peer country.

In 2016, Nigeria's global income peers had an average access rate of close to 84%. In Indonesia, for example, access to electricity is near universal, and Pakistan and India had access rates of 95% and 85% respectively. Both countries are likely to achieve universal access within fewer than 10 years from now.

On the current development trajectory, IFs forecasts a steady increase for access rates in Nigeria. By 2040, access rates in Nigeria are forecast to reach about 83%. Between today and 2040, over 160 million more Nigerians would get connected to the grid.

> Providing people with access to electricity is important. Yet in Nigeria, being connected to the grid does not translate into reliable electricity supply

The disparity between Nigeria and its global income peers is evident in both urban and rural electricity access. As of 2016, close to 84% of Nigeria's urban population had access to electricity. Meanwhile Pakistan, Indonesia and India all had universal access to electricity in urban areas. IFs forecasts that in the near to medium term, Nigeria will see a stagnation in the portion of those with electricity access in urban areas. This is probably due to continued high rates of urban population growth paired with slow growth rates and slow increases in government effectiveness.

However by 2040, IFs forecasts that Nigeria will reach a 99% urban access rate. As population growth and urbanisation are expected to slow towards the beginning of the 2020s (along with forecast economic growth rebound and improvements in government effectiveness), electricity access in urban areas is expected to improve and accelerate.

The story for access to electricity in rural areas is similar albeit more disparate. In 2015, only 34% of Nigerians living in rural areas had access to electricity. In Pakistan and Indonesia, around 90% of rural residents had access to electricity and in India 75% had access. IFs forecasts that rural electricity access in Nigeria will increase very little over the 23-year time horizon: from 34% today to 37% in 2040. Meanwhile India, Pakistan and Indonesia are forecast to reach nearly universal access by 2025 or earlier.

The generation and distribution problem

Providing people with access to electricity is important. Yet in the Nigerian context, being connected to the grid does not translate into reliable electricity supply. On the contrary, the enormous gap between generation capacity and demand, poorly maintained or completely dysfunctional plants as well as grid deficiencies lead to erratic electricity supply to both households and

IN 2016, ALMOST 58% OF NIGERIANS HAD ACCESS TO ELECTRICITY

companies.[59] Customers are exposed to extensive power outages, and the annual consumption of electricity per capita in Nigeria is among the lowest on the continent.[60]

The privatisation of parts of the country's power sector in 2013 has not led to significant improvements of the situation. Corruption is also to blame for the inefficiencies in the power sector.

Nigeria has about 12 500 GW of installed generation capacity which predominantly depends on fossil (gas) thermal power sources (87.5%) and to a much lesser extent on hydro (12.5%). However, of that capacity only 3 500 to 5 000 GW is typically available for transmission to the final consumer given the constraints relating to the country's generation and distribution capacity.[61]

In August 2017, electricity generation reached a record high of 6 700 MW.[62]

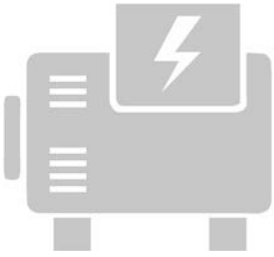
The fact that it had dropped as low as 2 662 MW in January of the same year due to vandalism of pipelines, however, illustrates the degree of volatility consumers face in Nigeria.[63]

> The lack of reliable and affordable electricity is often cited as the biggest drain on productivity and competitiveness for business in Nigeria

That said, Nigeria's problem is not limited to generation, and increases in generation capacity often get frustrated because the grid cannot take the additional load.

The lack of reliable and affordable electricity is often cited as the biggest drain on productivity and competitiveness for business in Nigeria, but it also compromises the smooth running of schools, clinics etc.[64] Most businesses in Nigeria and private households that can afford it rely on expensive standby diesel generators for their energy needs.

It is estimated that between 8 and 14 GW of decentralised diesel generator capacity is currently installed in Nigeria. About 86% of the companies in Nigeria own or share a generator which covers close to 50% of their total electricity demand.[65]



86% OF THE COMPANIES IN NIGERIA OWN OR SHARE A GENERATOR

Supplying over 160 million more people with electricity in the future comes with enormous challenges as generation, transmission and distribution capacity in Nigeria are seriously compromised.

Against this background it is only logical that the NIIMP emphasises improving generation capacity and expansion of transmission infrastructure as a priority for Nigeria.[66] It equally highlights the need for construction of supporting gas infrastructure.

The future of power generation in Nigeria is highly uncertain. The target on expanding power sector infrastructure set out in the ERGP is to 'optimize the

delivery of at least 10 GW of operational power capacity by 2020 to boost economic activity across all sectors and improve the quality of life of the citizenry'.[67]

Roads

Nigeria's road sector accounts for about 90% of all freight and passenger movement in the country,[68] largely due to the inadequacy of other forms of transportation, in particular rail.[69]

According to the NIIMP, Nigeria has a national road network of about 200 000 km. Of this total, federal roads make up only about 18%, but carry more than 80% of the vehicular traffic in the country. In fact, the federal roads have been subjected to severe pressure as a result of increased vehicular traffic as well as freight.

State roads account for 15% (about 17 000 km), and local government roads for 67% (about 150 000 km) of the total road network. Most local government roads are unpaved.[70] The planning, financing, construction and maintenance of these different types of roads fall under the separate responsibilities of Nigeria's three tiers of government.

As for the condition of the roads, according to the NIIMP, in 2012 about 40% of the federal road network was in poor condition and hence in need of rehabilitation; 30% was in fair condition requiring periodic maintenance; and 27% was in good condition requiring routine maintenance. The rest of the roads are unpaved and need to be paved. Of the state roads and local government roads, 78% and 87% respectively are in poor condition.[71]

Nigeria's road infrastructure, here measured as road density and percentage of paved roads, generally lags behind its global income peers. Nigeria is estimated to have only 2.1 km of total roads per thousand hectares of land area, whereas the average for Pakistan, India and Indonesia is around 11 km per thousand hectares. Even though India is over three times larger than Nigeria (in terms of land area), it is estimated to have over eight times the road density per thousand acres.

> Nigeria's road sector accounts for about 90% of all freight and passenger movement in the country

The story is much the same for paved roads. IFs estimates that 15.5% of Nigeria's roads are paved compared to an average of over 55% in the country's global income peers. In Pakistan, Nigeria's closest income, land and population peer, over 70% of roads are paved.

Looking forward, Nigeria is forecast to improve road density (per land area), increase road access for rural areas, and improve road quality by increasing the portion of roads that are paved. Nonetheless, the gap between Nigeria and its global income peers is likely to remain in place. Nigeria's continued population growth and recent economic downturn mean that increases in road access and quality are unlikely to keep up with the needs of the country (see Table 4 for road indicators forecast across time).

Table 4: Various road access and quality indicators, Nigeria and income peers, 2016 and 2040

	Nigeria		India		Indonesia		Pakistan	
	2016	2040	2016	2040	2016	2040	2016	2040
Total roads (thousand kilometres)	200	333	5 635	7 444	603	932	265	398
Road density (km per thousand hectares)	2.1	3.6	18.9	25	3.3	5.1	3.4	5.1
Paved (% of total roads)	15.5	56.5	55.3	81.2	57.5	78.3	73.8	81.6

Source: IFs v 7.29.

In summary, while Nigeria on its Current Path is expected to improve levels of access to basic infrastructure by 2040, the country is likely to still lag considerably behind both its African and its global income peers in particular.

Continued rapid population growth, relatively slow economic growth and limited prospects for improving government effectiveness at least partly explain such modest progress.

On the current development trajectory it is highly unlikely that Nigeria will meet universal access for clean water, improved sanitation and electricity as envisioned in the SDGs.

Accelerating Nigeria's infrastructure development to 2040

The analysis of Nigeria's current development trajectory makes it clear that without additional intervention, the country's infrastructure development will not progress fast enough to advance economic growth and human development. The infrastructure deficit cuts across all sectors, but it is most severe for access to water and sanitation.

> Without additional intervention, Nigeria's infrastructure development will not progress fast enough to advance economic growth

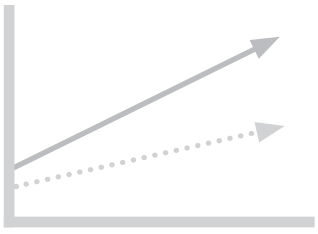
In response to this pessimistic forecast, this section presents six alternative interventions that reflect more ambitious approaches to improving infrastructure in Nigeria by 2040 than what is forecast in the Current Path. Each of the interventions described below represents an ambitious but realistic push to improve certain aspects of infrastructure in Nigeria over the next 23 years.

These interventions are meant to evaluate long-term outcomes and trade-offs of *successful* policy interventions across infrastructure sectors, rather than offer sector-specific policy and implementation guidance.

Each intervention is benchmarked to historical increases in infrastructure access in one or more of Nigeria's lower middle-income peers or is calibrated to ensure that Nigeria reaches the level of its African peers by 2040. Table 5 summarises the various interventions.

The Extending the Grid intervention represents a policy push to increase electricity access for Nigerians. The intervention increases the share of the population with access to electricity from 58% today to over 95% by 2040, representing a 14% increase over the Current Path in 2040. The pace of this increase in access mimics that of Pakistan between 1990 and 2012 and is slightly more ambitious than seen in Indonesia over the same time period.

The Boosting Road Access intervention represents an effort to increase both gravel and paved road access across the country. This intervention increases



NIGERIA'S URBAN POPULATION IS GROWING MUCH FASTER THAN ITS RURAL POPULATION BUT IS EXPECTED TO PLATEAU AND DECLINE AROUND 2025

Table 5: Description of interventions

Intervention	Outcome
Extending the Grid	Increases total electricity access from 58% to 95% over the next 23 years.
Boosting Road Access	Increases total road network from 202 000 km to 400 000 km and paved road length from 30 000 km to 260 000 km over the next 23 years.
Increasing Sanitation Access	Increases access to improved sanitation facilities from 30% to 67% over the next 23 years.
Improving Water Access	Increases access to safe water sources from 70% to 86% over the next 23 years.
Broad Infrastructure Push	Combines all the above interventions.
Broad Infrastructure Push + Family Planning	Combines all infrastructure interventions with a family-planning scenario that reduces Nigeria's fertility rate from 5.4 to 3.3 over the next 23 years.

total road length from just over 200 000 km today to just below 400 000 in 2040 and increases the portion of paved roads from 16% today to nearly 66% in 2040. This scenario represents a 20% increase in total roads and a 40% increase in the portion of paved roads compared to the Current Path. The intervention brings Nigeria's road density in line with both Indonesia and Pakistan by 2040.

The Increasing Sanitation Access intervention represents a concerted effort to extend improved sanitation facilities in Nigeria over the next 20 years. It increases the share of the population with access to improved sanitation facilities from 29% today to 67% by 2040. This represents a 50% increase over the Current Path in 2040 and follows a similar path to that of Pakistan between 1995 and today.

> Nigeria's infrastructure deficit cuts across all sectors, but is most severe for access to water and sanitation

While this intervention is aggressive, it is less aggressive than the target that is included in Nigeria's PEWASH strategy, i.e. to reach universal access to improved sanitation in rural areas by 2030. That said, the IFs intervention is of course different as it targets overall access to improved sanitation and not only access in rural areas.

This seems sensible given that Nigeria's urban population is growing much faster than its rural population, which is expected to plateau over the coming years before it starts declining in around 2025. In addition, in 2015, access to improved sanitation in urban areas was not significantly higher than in rural areas (close to 33% versus less than 25% respectively).[72]

The Improving Water Access intervention represents a similar effort to increase access to clean water. This intervention increases the share of the population with access to clean water from 70% today to 86% in 2040. It increases access at a slightly slower pace than India between 1990 and 2013 and represents a 20% increase over the Current Path in 2040.

The Broad Infrastructure Push scenario combines all of the above interventions to simulate a broad policy push to improved access to infrastructure in Nigeria. In addition, we have included a Broad Infrastructure Push + Family Planning intervention to demonstrate the effects of a cross-sectoral policy push to improve infrastructure and slow population growth. This scenario includes an intervention on Nigeria's fertility rate. The intervention lowers fertility from 5.4 births today to 3.3 in 2040, representing a 38% decrease compared to the Current Path in 2040. This reduction is very similar to the reduction seen in Ethiopia's fertility rate between 1995 and 2015.

Impact on the economy and human development

This report focuses on the critical importance of access to basic infrastructure for both economic growth and human development (thereby making the case for a holistic approach to infrastructure). The size of the

economy measured in GDP at market exchange rate (MER), the share of the population living in extreme poverty (below US$1.90), the number of malnourished children as well as infant mortality are all commonly used indicators to assess economic and human development.

Table 6 summarises the improvements and trade-offs of pursuing each of the infrastructure scenarios across a number of indicators. Values represent the difference in the outcome indicator in 2040 compared to the Current Path; darker green represents a better outcome compared to other scenarios.

Table 6: Outcome comparison across various indicators (difference compared to the Current Path)

	Extending the Grid	Boosting Road Access	Increasing Sanitation Access	Improving Water Access
Increase in GDP (billions)	5.00	3.00	25.00	18.00
Increase in GDP per capita (percent)	0.33	0.20	1.55	1.10
Reduction in number of individuals living in extreme poverty (millions)	-0.5	-0.3	-2	-1.5
Change in infant mortality (percent)	-1.38	0.14	-13.46	-5.60
Reduction in number of malnourished children (millions)	-0.024	0.003	-2.502	-0.979
Increase in modern fuel cookstoves (millions)	7.20	0.10	0.82	0.69
Increase in paved roads per capita (percent)	0.05	39.67	0.31	0.19
Change in life expectancy (in years)	0.11	-0.01	0.78	0.35

Source: IFs v 7.29.

THE INCREASING SANITATION ACCESS SCENARIO HAS THE GREATEST IMPACT ON POVERTY REDUCTION, HEALTH AND ECONOMIC EXPANSION

The Increasing Sanitation Access scenario has the greatest impact on poverty reduction as well as on the expansion of the economy. Instead of 141 million people forecast to live in extreme poverty by 2040 on the Current Path, 139 million people would be living in extreme poverty (2 million fewer). Nigeria's economy would be more than 2% larger than on the Current Path.

Increasing Sanitation Access also has the greatest benefits on health. It decreases the number of malnourished children by 2.5 million, reduces the rate of infant mortality by 14%, and increases life expectancy by nine months compared to the Current Path in 2040. The Improving Water Access intervention has the second biggest impact on infant mortality and the number of malnourished children (comparing the four individual interventions).

Unsurprisingly, the Boosting Road Access intervention has a huge impact on the number of paved roads per capita and the Extending the Grid intervention has the largest impact on the number of households using modern fuel sources. However, the Boosting Road Access intervention also has the weakest impact on poverty reduction as well as on the size of the Nigerian economy. The Extending the Grid intervention yields only slightly better results on poverty reduction, and GDP per capita and GDP at MER, than the roads intervention.

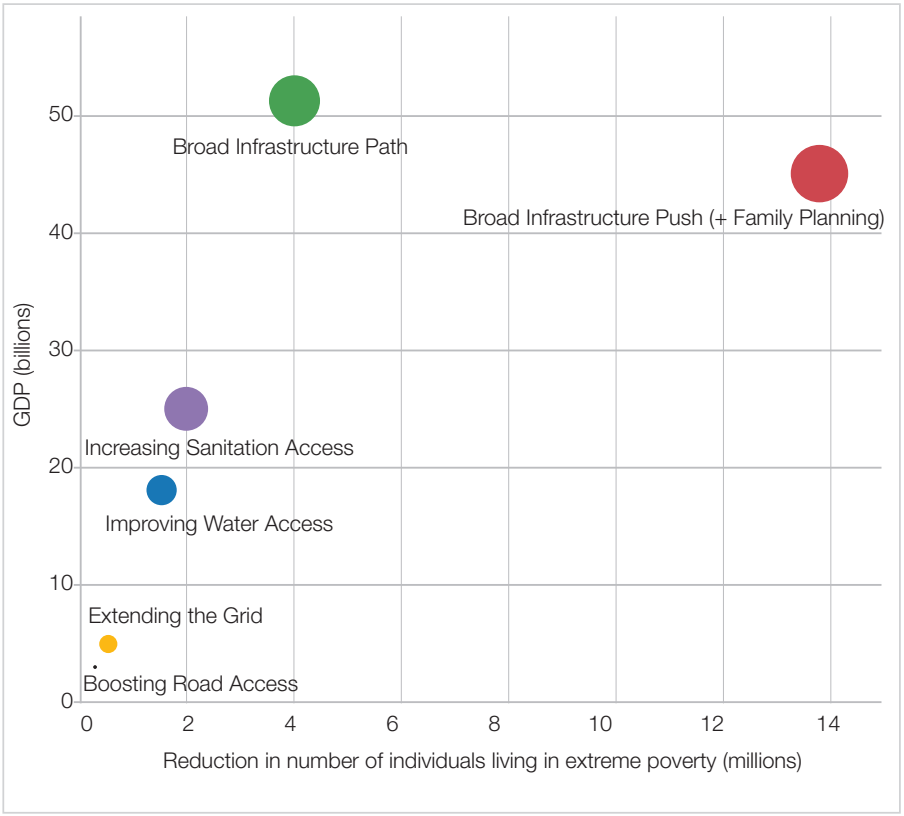
Almost all interventions have a positive impact across the outcome variables with the exception of the roads intervention, which slightly increases infant mortality as well as the number of malnourished children.

The IFs traditional infrastructure index referred to earlier in this report allows for a more general way of assessing where Nigeria could be compared to where it is expected to be in terms of infrastructure development. Under the Broad Infrastructure Push scenario, Nigeria would rank 47th out of 51 global lower middle-income countries compared to second-last, as it is on the Current Path forecast.

> The Boosting Road Access intervention has the weakest impact on poverty reduction and the size of the Nigerian economy

Figure 8 shows the effects of the different interventions and the two combined scenarios for Nigeria across three development indicators in 2040 (compared to the Current Path forecast). The vertical axis represents the change in GDP at MER, the horizontal axis measures the change in the number of people living in extreme poverty, and the bubble size represents the change in life expectancy (years).

Figure 8: Bubble diagram of the different interventions



Source: IFs v 7.29.

UNDER THE BROAD INFRASTRUCTURE PUSH SCENARIO, NIGERIA WOULD RANK

47th out of 51

GLOBAL LOWER MIDDLE-INCOME COUNTRIES COMPARED TO SECOND-LAST, AS IT IS ON THE CURRENT PATH FORECAST

Figure 8 helps to illustrate the benefits of a concerted push to improve infrastructure across all four sectors and shows that pairing infrastructure investment with family planning could have a large impact on both GDP and poverty. The Broad Infrastructure Push boosts GDP by over US$50 billion and reduces those in extreme poverty by over 4 million by 2040 (compared to the Current Path).

Meanwhile, the Broad Infrastructure Push + Family Planning scenario has a large impact on the number of people who live in extreme poverty, albeit a smaller impact on GDP. The scenario reduces the number of those living in extreme poverty by nearly 14 million and increases GDP by about US$45 billion (compared to the Current Path) by 2040.

Past and future infrastructure spending and the funding and financing challenge

Generally Nigeria is constrained by limited government capacity, understood as the ability of the government to 'effectively formulate and implement sound policies'.[73] Poor government capacity also inhibits the country's ability to mobilise revenues and allocate them effectively, and manage innovative funding models for infrastructure. It can also make corruption more likely, in particular for large-scale, expensive projects.[74]

> Poor government capacity inhibits Nigeria's ability to mobilise revenues and allocate them effectively, and manage innovative funding models for infrastructure

The ERGP lists poor sector governance in terms of project selection, funding models and oversight, as well as 'weak project execution', as the main obstacles to expanding Nigeria's infrastructure base and to improving the quality of infrastructure.[75]

It is difficult to get hold of reliable data on infrastructure spending in Nigeria. The figures from different sources tend to vary greatly and are often not comparable, also because they are often not based on the same definition of infrastructure.

According to the Global Infrastructure Outlook report, Nigeria's annual average public investment in infrastructure across the sectors of transport (rail, roads, airports and ports), energy, telecommunications and water between 2007 and 2017 was equivalent to about 3.6% of GDP and did not surpass 4.6% of GDP in any given year during that period.

This means that Nigeria effectively spent below the annual average infrastructure investment in Africa which accounted for about 4.3% of GDP during the same period of time.

In the past and in terms of sectors, Nigeria clearly prioritised investing in transport – particularly roads and ports[76] – and in energy infrastructure.

NIGERIA IS EXPECTED TO SPEND ON AVERAGE ABOUT

3.7%

OF GDP ON INFRASTRUCTURE PER YEAR BETWEEN 2017 AND 2030 AND CLOSE TO

3.1%

OF GDP BETWEEN 2030 AND 2040

Between 2007 and 2017, annual average investment in transport accounted for 1.7% of GDP (1% for roads and 0.5% for ports), and 1.1% of GDP was spent on energy infrastructure. Spending on telecommunications ranked third – roughly 0.7% of GDP – while spending on water accounted for only about 0.2% of GDP during the same period.

To think about the future, the Global Infrastructure Outlook offers three different forecasts: first, a baseline forecast to reflect infrastructure investment based on the assumption that countries continue to invest in line with current trends, with growth occurring only in response to changes in each country's economic and demographic fundamentals. Second, an 'investment need' forecast to demonstrate the investment that would occur if countries were to match the performance of their best performing (income) peers, after controlling for differences in the characteristics of each country. Lastly, a forecast that estimates how much a country would need to spend to achieve the relevant SDGs.[77]

The main investment need scenario is benchmarked against what countries with similar income levels have actually achieved, while the SDG scenario incorporates the much more challenging objective of meeting the SDG targets for universal access to water, sanitation and electricity.

> Government revenue is still very dependent on oil and vulnerable to volatility on international energy markets

Based on past levels of spending and the assumption that Nigeria is likely to continue to spend in line with current trends, the country is expected to spend on average about 3.7% of GDP on infrastructure per year between 2017 and 2030 and close to 3.1% of GDP between 2030 and 2040. If, on the other hand, the country was to match the best performing countries in its income peer group (investment need scenario), the Nigerian government would have to increase annual average infrastructure spending to about 4.8% of GDP between 2016 and 2030 and to about 3.8% of GDP between 2030 and 2040. These figures increase to 6.8% and 3.8% of GDP respectively if Nigeria were to achieve universal access to water and sanitation by 2030.

For Africa, the investment need scenario is equivalent to 5.9% of GDP, up from 4.3% between 2007 and 2015.[78] According to the Global Infrastructure Outlook: 'While this will clearly be challenging, our analysis suggests that since 2007 Ethiopia, Morocco, Tanzania and Angola have all achieved infrastructure investment levels of 5.5 percent of GDP or more.'[79]

The funding and financing challenge

Building new infrastructure is expensive and takes time. Alongside government effectiveness constraints, funding and financing are among the greatest challenges for Nigeria.[80]

Nigeria's government revenue is still very dependent on oil and therefore vulnerable to volatility on international energy markets. This has direct implications for the budget and allocations for infrastructure development. At the same time, the sheer size of the Nigerian market is a magnet for potential investors. In fact, Nigeria is the largest infrastructure market on the continent.[81] However, the investment climate in Nigeria is considered very complex.

Against this background, the ERGP states that 'given the huge capital layout required to address the massive infrastructure deficit in the country, the private sector is expected to play a key role in providing critical infrastructure, either directly or in collaboration with the Government under public private partnership (PPP) arrangements'.[82]

According to Oxford Economics, Nigeria's cumulative infrastructure spending need (investment need scenario) between 2016 and 2040 is about US$878 billion while the expected spending would be about US$657 billion, leaving a gap of over US$200 billion.[83] Based on what is needed, this translates into an average investment of over US$36 billion per year. The NIIMP puts forward a figure of US$100 billion annually until 2045, a figure 'almost three times larger than the combined overall budget expenditure of both the federal and state governments'.[84] And finally, in 2013, the African Development Bank estimated that Nigeria would need to invest US$15 billion a year to meet its infrastructure needs.[85]

Conclusion

Nigeria needs to invest heavily in basic physical infrastructure to meet the needs of its rapidly growing population and underpin economic growth and human development.

Building such infrastructure and increasing levels of access for citizens is expensive and takes time. It requires better integrated long-term planning, higher levels of government effectiveness and effective implementation, apart from innovative funding and financing models. Addressing multiple infrastructure deficits across several categories at the same time presents Nigeria with an additional challenge in terms of prioritisation.

In light of these challenges, this report introduced and analysed the long-term effects of successful policy interventions in four core infrastructure areas on various development and economic indicators. Each intervention represented an ambitious but reasonable policy push to improve access to roads, water, sanitation and electricity in Nigeria over the next 23 years. This report also analysed the long-term effects of an integrated infrastructure scenario (across all four infrastructure sectors). Given the importance of Nigeria's rapid population growth, the report also analysed an integrated infrastructure scenario paired with a family planning scenario.

> Improved water and sanitation interventions yield better economic impacts than either the roads or energy interventions

Of the four interventions, increased access to improved sanitation and safe water have the largest direct impact on development indicators (notably health) and economic growth by 2040. Meanwhile, the integrated infrastructure scenario paired with family planning shows that a successful policy push across infrastructure sectors and family planning could have significant effects on both poverty and overall economic output in Nigeria over the next 23 years.

Access to basic infrastructure such as water and sanitation have historically been overlooked in Nigeria due to a short-sighted economic focus on energy and transportation infrastructure, in particular roads. In fact, the current ERGP emphasises investment in infrastructure, especially in power, roads, rail, ports and broadband networks to improve the national infrastructure backbone. But, it fails to acknowledge water and sanitation infrastructure which reflects a general lack of awareness of the importance of these sectors for the economy.

This reports shows that improving infrastructure, especially access to water and sanitation, could be an effective lever to spur economic growth and improve human development outcomes in Nigeria. There are many benefits of investing in clean water and improved sanitation – health more directly,

POLICY COORDINATION AND IMPLEMENTATION ACROSS INFRASTRUCTURE AND HEALTH SECTORS COULD SIGNIFICANTLY IMPROVE BOTH ECONOMIC AND HUMAN DEVELOPMENT OUTCOMES

but also secondary economic benefits from human capital. Both the water and sanitation interventions yield better economic impacts than either the roads or energy interventions.

Further, it shows that policy coordination and implementation across infrastructure and health sectors could significantly improve both economic and human development outcomes.

Notes

Special thanks to Zachary Donnenfeld, Jakkie Cilliers, Oladiran Bello, Olaseni Akintola-Bello, Steve Hedden, and Lily Welborn for helpful comments on earlier drafts of the report.

1 In this report, basic physical infrastructure and basic infrastructure are used interchangeably.

2 Infrastructure is one out of 12 pillars that the World Economic Forum (WEF) uses to assess the overall competitiveness of economies in the world. Infrastructure is part of the Subindex A basic requirements alongside institutions, macroeconomic environment, primary education and health. Nigeria's overall competitiveness is ranked 127 out of 138.

3 WEF, The Global Risks Report 2017, 12th edition, Appendix C: The Executive Opinion Survey 2016: Views of the Business Community on the Global Risks of Highest Concern for Doing Business http://reports.weforum.org/global-risks-2017/appendix-c-the-executive-opinion-survey-2016-views-of-the-business-community-on-the-global-risks-of-highest-concern-for-doing-business/). More than 22% of the respondents name this as the number one factor that is problematic for doing business, followed by 15% who mention corruption.

4 Alongside 'corruption and mismanagement of public finances'.

5 Federal Republic of Nigeria, Economic Recovery & Growth Plan, Ministry of Budget and Planning February 2017-2020, 11 (https://estateintel.com/wp-content/uploads/2017/03/Nigeria-Economic-Refom-Plan-2.pdf).

6 Federal Republic of Nigeria, Nigeria Integrated Infrastructure Master Plan (NIIMP) (http://www.niimp.gov.ng/).

7 FG inaugurates working group on $3 trillion infrastructure master plan, *Nigeria News Network*, 20 June 2017, https://nnn.com.ng/nigerianews/tribune/fg-inaugurates-working-group-on-3-trillion-infrastructure-master-plan/.

8 On this trajectory, by 2040, Nigeria would become the fourth most populous country in the world, behind only India, China and the United States of America.

9 Within International Futures (IFs), infrastructure is categorised as core infrastructure (roads, water and sanitation and electricity), other infrastructure (airports, seaports and infrastructure yet to be envisioned) and information and communication technology (ICT) infrastructure.

10 Increasing access to ICT has important implications for economic and human development. However, investment and adoption of ICT services operates somewhat differently to traditional forms of physical infrastructure. Adoption and coverage is largely a function of market forces (as long as ICT is not state controlled or heavily regulated) and follows a different path to traditional infrastructure. There has been a nearly exponential increase in ICT access over the past 15 years across the globe (and in Nigeria) and we forecast it to continue to rapidly rise in the short to medium term and then flatten out as ICT services reach saturation point.

11 The World Health Organisation/United Nations Children's Fund (WHO/UNICEF), Joint Monitoring Programme: Improved and Unimproved Water Sources and Sanitation Facilities, https://washdata.org/monitoring/drinking-water.

12 Ibid.

13 WHO/UNICEF, Joint Monitoring Programme: Improved and Unimproved Water Sources and Sanitation Facilities, https://washdata.org/monitoring/sanitation.

14 Based on Alanna Markle and Zachary Donnenfeld, Refreshing Africa's future. Prospects for achieving universal WASH access by 2030, African Futures Paper 17, June 2016.

15 IFs is a free, open-source model used for thinking critically about development futures. It is hosted and developed by the Frederick S. Pardee Center for International Futures at the University of Denver (see

http://pardee.du.edu/understand-interconnected-world) and was originally created by Professor Barry B Hughes.

16 These variables were adjusted in IFs by manually reducing the multiplier on each variable over time. The road network density multiplier (infraroadm) was interpolated from 1 to .92 from 2017 to 2040; the paved roads as a percent of total multiplier (infraroadpavedppcntm) was interpolated from 1 to .85 from 2017 to 2040; the maximum oil production multiplier (enpoilmax) was reduced to .85 for 2015-16 and then interpolated from .85 to 2 from 2017 to 2040; the maximum natural gas production multiplier was interpolated from .35 to .75 from 2015 to 2040.

17 Lower middle-income economies are those with a GNI per capita, calculated using the World Bank Atlas Method, of between $1,006 and $3,955 (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).

18 Jakkie Cilliers, Julia Schünemann, Jonathan Moyer, Power and influence in Africa: Algeria, Egypt, Ethiopia, Nigeria and South Africa, March 2015, Institute for Security Studies.

19 All figures are in constant 2011 USD$ unless otherwise stated.

20 William Ascher and Corinne Krupp, Distributional Implications of Alternative Financing of Physical Infrastructure Development. In *Physical Infrastructure Development: Balancing the Growth, Equity, and Environmental Imperatives* (pp. 35–68), 2010, Springer, retrieved from http://link.springer.com/chapter/10.1057/9780230107670_2.

21 Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all; Target 6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defaecation, paying special attention to the needs of women and girls and those in vulnerable situations.

22 Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.

23 See https://sustainabledevelopment.un.org.

24 Dale S Rothman, Mohammod T. Irfan, Eli Margolese-Malin, Jonathan D. Moyer, Building global infrastructure, Patterns of potential human progress, Volume 4, Pardee Center for International Futures, Oxford University Press, 6.

25 Calestous Juma, Leapfrogging progress, The misplaced promise of Africa's mobile revolution, 2017, https://thebreakthrough.org/index.php/journal/issue-7/leapfrogging-progress

26 Ibid.

27 Global Infrastructure Outlook, Infrastructure investment needs, 50 countries, 7 sectors to 2040, Oxford Economics, July 2017, 8.

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34 The IFs Traditional Infrastructure Index includes key indicators across the categories of transportation (total roads per 1 000 persons, total roads per 1 000 hectares, rural access index, % of roads paved), energy (electrical generation capacity per capita, percentage of population with access to electricity (total), transmission loss (%), ratio of electricity use to total primary energy use), and water and sanitation (% of population with access to improved water; % of population with access to improved sanitation; % of population with wastewater treatment). Due to the interaction effects across infrastructure types, IFs does not attempt to estimate the impact of individual forms of infrastructure but rather estimates the impact as a function of a composite index of infrastructure. See Dale S Rothman et al, 201.

35 EGRP, 54; Calestous Juma, Infrastructure for innovation, in *New African*, June 26, 2015, http://newafricanmagazine.com/infrastructure-for-innovation/.

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38 Dale S Rothman et al, ibid.

39 Dale S Rothman et al, ibid., 102. The impact of natural resources is represented through the effect of energy prices on multifactor productivity.

40 To calculate the impact of basic infrastructure (excluding ICT) on multifactor productivity, the IFs Traditional Infrastructure Index compares the value of the index for a country to a benchmark function that indicates what value would be expected for a country given its current level of GDP per capita. For countries like Nigeria where the index value falls below the benchmark value, infrastructure represents a drag on the physical capital component of multifactor productivity. 'The size of the boost or reduction depends on the distance from the benchmark value and a factor relating this distance to productivity.' See Dale S Rothman et al, ibid., 102-103. Moreover, due to the very different historical and expected growth patterns of traditional infrastructure – transportation, energy, and water – regarding ICT, IFs includes a separate index for ICT which affects MFP differently. See Rothman et al, 201.

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50 USAID, http://pdf.usaid.gov/pdf_docs/Pnado937.pdf.

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52 This 'expected' value is based on a regression with GDP per capita as the independent variable and the outcome indicator as the dependent variable. This technique and terminology will be used several times throughout the report.

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66 NIIMP, ibid.

67 ERGP, ibid., 15.

68 NIIMP, 25. Nigeria has a national road network of about 200 000km. Of this total, federal government roads make up 18% (about 35 000 km), state roads 15% (about 17 000 km), and local government roads 67% (about 150 000 km), with most local government roads being unpaved (NIIMP, 25).

69 Compendium report for road infrastructure and related development in Nigeria – an investor's manual, 2013, 9. Road became the priority mode of transport since the collapse of the rail system in the 1970s/'80s.

70 NIIMP, ibid., 25.

71 NIIMP, ibid., 25.

72 https://data.worldbank.org/indicator/SH.STA.ACSN.UR?locations=NG&view=chart.

73 Definition as per the World Bank's Worldwide Governance Indicators, http://info.worldbank.org/governance/wgi/index.aspx#home.

74 Global Infrastructure Outlook, ibid., 56.

75 ERGP, ibid., 78.

76 Global Infrastructure Outlook, ibid., 60: 'Ports investment is estimated to have been substantially higher in Nigeria than in other African countries since 2007, boosted by the government's Port Reform Programme, which proved successful in attracting private investment to address limitations in the country's ports sector.'

77 Global Infrastructure Outlook, ibid., 23.

78 Global Infrastructure Outlook, ibid., 28.

79 Global Infrastructure Outlook, ibid., 58.

80 Funding refers to the money provided a government sector or companies for a specific purpose, whereas, financing is a process of receiving capital or money from financial institutions, such as, banks or other lending agencies.

81 Global Infrastructure Outlook, ibid.

82 ERGP, ibid., 14.

83 Global Infrastructure Outlook, ibid., 59.

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About the authors

Julia Bello-Schünemann is a senior researcher for the African Futures and Innovation programme at the ISS. Before joining the ISS, she was a consultant working on peace and state building, providing policy advice to the European Union (EU) and United Nations Development Programme (UNDP), among others. Bello-Schünemann has a PhD in international relations from the Complutense University of Madrid, Spain.

Alex Porter is a researcher at the Frederick S. Pardee Center for International Futures at the University of Denver. Previously he was a research consultant for the African Futures and Innovation programme at the ISS. Porter holds an MA in Global Finance, Trade and Economic Integration from the Josef Korbel School of International Studies at the University of Denver.

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The African Futures Project is a collaboration between the ISS and the Frederick S. Pardee Center for International Futures at the Josef Korbel School of International Studies, University of Denver. The African Futures Project uses the International Futures (IFs) model to produce forward-looking, policy-relevant analysis based on exploration of possible trajectories for human development, economic growth and socio-political change in Africa under varying policy environments over the next four decades.

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