Nigeria—Additional Spending Toward Sustainable Development Goals

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IMF, IMF SGH Warsaw School of Economics, World Bank

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Nigeria
Additional Spending Toward Sustainable Development Goals

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Technical Report
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APPENDICES

ABBREVIATIONS

ADV/AE	Advanced economies
EME	Emerging market economies
EU	European Union
GDP	Gross Domestic Product
IMF	International Monetary Fund
JMP	Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
kW	kilowatt
kWh	kilowatt hour
LIDC	Low-income and developing countries
MW	Megawatt
MWh	Mega-Watt hour
RAI	Rural Access Index
REA	Rural Electrification Agency
SDGs	Sustainable Development Goals
SE4ALL	Sustainable Energy for All program
UN	United Nations
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

PREFACE

In response to a request from the Office of the Senior Special Assistant to the President on Sustainable Development Goals (OSSAP-SDGs), a technical mission visited Abuja, Nigeria during January 29–February 11, 2020 to collaborate on an assessment of the spending associated with making substantial progress along the Sustainable Development Goals (SDGs). The mission comprised Mauricio Soto (head) and Mariano Moszoro (all FAD), and Julieth Pico (FAD expert). This technical misisiont was financed by the European Union under the EU-IMF Public Financial Management Partnership Program (PFM-PP)

The mission was hosted by D.M. Dauda (Secretary of Programme, OSSAP-SDGs) and Dr. Bala Yusuf Yunusa (Senior Technical Advisor, OSSAP-SDGs).

The mission met with Zainab Shamsuna Ahmed (Minister of Finance, Budget, and National Planning), Prince Clem Ikanade Agba (Minister of State for Budget and National Planning), and Suleiman H, Adamu (Minister of Water Resources). The mission also met with Didi Walson-Jack (Permanent Secretary, Federal Ministry of Power), Emmanuel Meribole (Director, Health Planning, Research and Statistics, Ministry of Health), Babangida Hussaini (Director of Special Projects, Federal Ministry of Works and Housing), and Adeoye E.O. (Acting Director, Department of Educational Planning, Research, and Development, Federal Ministry of Education).

The mission also met Katrine Mulvad Thomsen (Team Leader, Economic Cooperation and Energy, European Union Delegation), Amarakoon Bandara (Senior Economic Advisor, UNDP), Shubham Chaudhuri (Country Director, World Bank), Moses Ongom (Health System Adviser, WHO), Anthony Simpasa (Lead Economist, African Development Bank), and other staff of development partners.

The mission expresses its sincere appreciation for the cooperation and support given by officials and staff of these various organizations with whom the mission met. The team is especially grateful to Chukwuemeka Olanrewaju Ogbuehi (Ministry of Finance), Ogunleye Femi (OSSAP-SDG), and Zainab Mangga (IMF Resident Representative Office) for the excellent coordination and support during the mission. The mission is also thankful to Laraba Bonet (IMF Resident Representative Office) for facilitating mission logistics.

EXECUTIVE SUMMARY

Making progress in the SDGs requires substantial additional resources. Concomitant with the reform priorities identified by the United Nations, World Bank, European Union, and other international development institutions, the mission estimates additional spending of 18 percentage points of GDP by 2030—a level higher than the average low-income and developing countries. Relative to other low-income and developing countries, additional spending is higher in education and water and sanitation, and lower in health, electricity, and roads (Figure).

Given scarce resources, a long-term vision is imperative. Given scarce resources, a long-term vision is imperative. The authorities have made important progress in developing long-term plans in sectors such as health, electricity, and water and sanitation.

- *Education—increasing access and improving quality.* The relatively low resources devoted to education are insufficient to deliver quality education for all. With 50 percent of the population in school-age, we estimate that total annual spending in education would need to increase by 7.7 percentage points of GDP by 2030. A pragmatic approach should be taken depending on resource availability. For example, expanding enrollment could be done at a more modest cost of some 1 percentage points of GDP.

- *Health—tackling inefficiencies.* Nigeria should deliver better outcomes at its current level of spending. Rebalancing the system, with an emphasis on primary care with public support, is critical. In the medium-term, additional annual spending of 4 percentage points of GDP would be needed to expand health workers, improve infrastructure, and improve health outcomes.

- *Electricity—rehabilitating and expanding power infrastructure.* Annual investments of 1 percent of GDP are needed to expand electricity access and keep up with population growth. Rehabilitating the existing capacity can help meeting part of these investments. Mini-grids can play an important role in mobilizing capacity to remote and vulnerable communities.

- *Roads—expanding the road network.* Increasing access roads from 26 to 75 percent of the rural population will cost 2 percent of annual GDP. It is critical to outline the road network and identify projects with high economic and social returns. The private sector can play an important role in this sector, supported by strong oversight to ensure value for money.

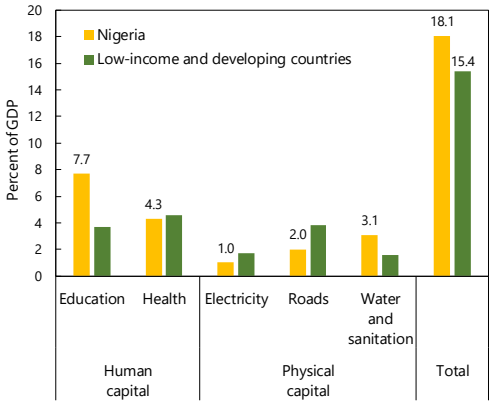
- *Water and sanitation—picking low-hanging fruit.* A priority is improving access for the most vulnerable. Ending open defecation and expanding basic water and sanitation can be achieved at a modest annual cost of 0.6 percent of GDP. In the medium-term, providing safely managed water and sanitation for all will cost an additional 2.5 percent of annual GDP.

Beyond resources, improving coordination and strengthening governance is critical to delivering on the SDGs. The federal administration through its Office of the Senior Special Assistant to the President on Sustainable Development Goals (OSSAP-SDGs) is committed to advance towards the 2030 goals. In line with policy options outlined by the World Bank and the United Nations, progress in these sectors requires a whole-of-government approach, supported by strong coordination between the federal, state, and local administrations. While development partners and the private sector can help, the government should be in the driving seat of these efforts. To support decision-making based on evidence, one priority is to collect and analyze data to inform best practices and better target scarce resources.

Figure. Spending in Critical SDG Sectors

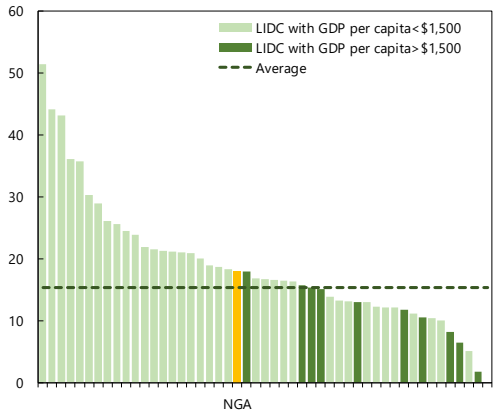
By Sector

(Percent of 2030 GDP)



In Low-Income and Developing Countries

(Percent of 2030 GDP)



Source: IMF staff calculations.

I. INTRODUCTION

1. Nigeria faces serious development gaps. Half of the student-age population is enrolled in schools. Healthy life expectancy is 49 years, placing Nigeria among the bottom six countries in the world. Some 54 percent of the population is connected to an electricity grid that collapses about once a month. Roads are in precarious condition. Less than 4 percent of the population have access to safely managed water. Overall, Nigeria's indicators of human and physical capital are worse than countries with lower GDP per capita.

2. Unlocking the potential of a rapidly growing population requires substantial improvements in human and physical capital. Nigeria is Africa's most populous country and its largest economy. Its population is projected to grow by 30 percent—about 60 million people—between now and 2030. To raise living standards, reduce poverty, and provide better opportunities for the growing youth, Nigeria needs to invest more on its people—education and health—and its infrastructure—roads, electricity, and water and sanitation.

3. Recognizing these challenges, Nigeria has embraced the Sustainable Development Goals (SDGs) Agenda. The Economic Recovery and Growth Plan 2017–2020 gives prominence to economic, social and environmental issues. An important step was the establishment of a special office within the presidency responsible for coordination, planning, communications, and advocacy around the SDGs agenda.[1] The federal government has included specific programs to support the SDGs in the budget. The nation is recognizing that an all-government approach (including federal, state, and local governments) is required to make progress along the SDGs.

4. This report assesses additional spending associated with making substantial progress along the SDGs. The report focuses on critical areas of human (education and health in Section II) and physical (electricity, roads, and water/sanitation in Section III) capital. For each sector, the report documents progress to date, assesses Nigeria relative to peers, highlights challenges, and estimates the spending to make substantial SDG progress.[2] For education and health, we report additional spending in percentage points of GDP, corresponding to the difference between the share of GDP in spending consistent with high performance in 2030 and the current level of spending as a share of GDP. For physical capital, additional spending in percentage points of GDP corresponds to the annualized spending required to close infrastructure gaps between 2019 and 2030. A set of appendices discuss the main assumptions, data, and methodological issues for each sector (appendices I to VI).

[1] Nigeria has defined a path for implementing the 2030 Agenda (2015), made progress in developing baseline and tracking statistics (2016), and implemented a national review of SDG implementation progress. A recent scenario analysis which illustrated the challenge of the SDGs. For example, even under an optimistic scenario, the SDG indices that set 100 percent for SDG achievement would remain under 60 percent for health and education.

[2] The costing is done following the methodology developed by Gaspar and others. 2019. Fiscal Policy and Development: Human, Social, and Physical Investment for the SDGs. IMF Staff Discussion Note.

II. HUMAN CAPITAL

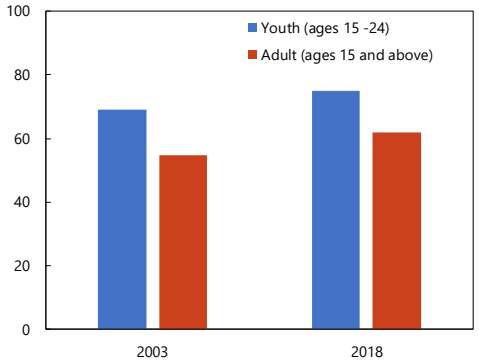
A. Education

5. Nigeria has shown gradual improvements in education. The share of literate adults increased from 55 percent in 2003 to 62 percent in 2018 (Figure 1.a). In the same period, increases in enrollment raised the average number of years of schooling by 2 years (Figure 1.b). To boost outcomes, the authorities launched in 2018 a strategic four-year plan, which focuses on improving access and quality.[3]

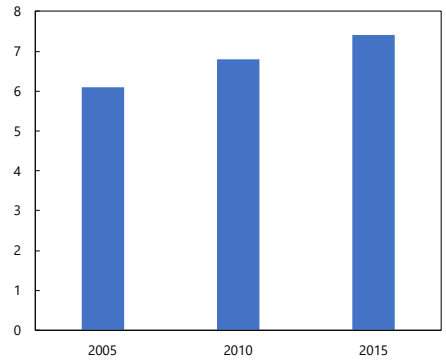
Figure 1. Trends in Educational Outcomes

a. Youth and Adult Literacy Rate

(Percent of Population)



b. Average Years of Schooling



Source: IMF staff calculations using World Development Indicators and UNDP (2019).

6. The education system is falling short. Like many other low-income and developing countries, Nigeria faces the challenge of educating large numbers of children in relation to the population.[4] Today, over half of the population is of school-age, compared to 36 percent in emerging economies and 25 percent in the advanced economies (Figure 2.a). Nigeria is failing this demographic challenge. Half of the school-age population (Figure 2.b) —nearly 50 million Nigerian children and youth—are not receiving any formal education.

7. Furthermore, the education system seems to deliver poor quality to those enrolled. Nigeria ranks low in quality measures among low-income countries. For example, only 20 percent of pupils that complete primary school can read a three-sentence passage fluently or with little help, compared with 50 percent in Ghana and 80 percent Rwanda and Tanzania.[5] Among

[3] See: Nigeria's "Education for Change: A Ministerial Strategic Plan 2018–2022", Federal Ministry of Education

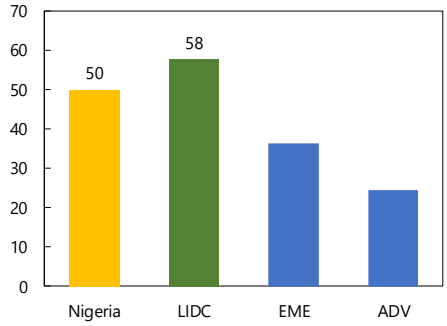
[4] Hasan, Rifat Afifa and others, 2019, "Nigeria's Demographic Dividend?" 2017–2020. World Bank.

[5] Filmer, D., Langthaler, M., Stehrer, R., & Vogel, T. ,2018, Learning to Realize Education's Promise, World Development Report, World Bank.

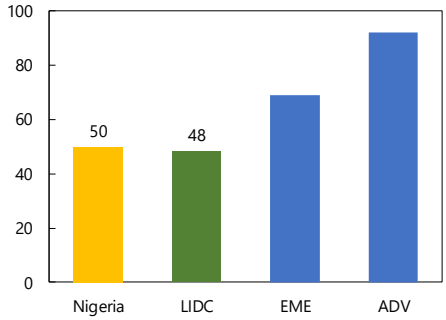
44 economies in Africa, Nigeria is in 39th place in harmonized tests scores.[6] This lower quality is equivalent to losing about 4 years of schooling.[7]

Figure 2. Demographics and Enrollment

a. School-Age Population
(percent of total population)



b. Enrollment Rate
(percent of school-age population)

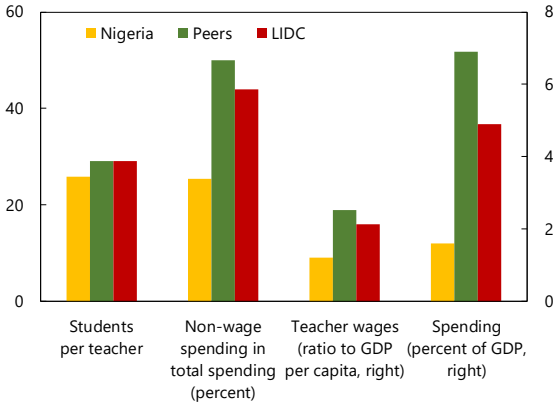


Source: IMF staff estimates.

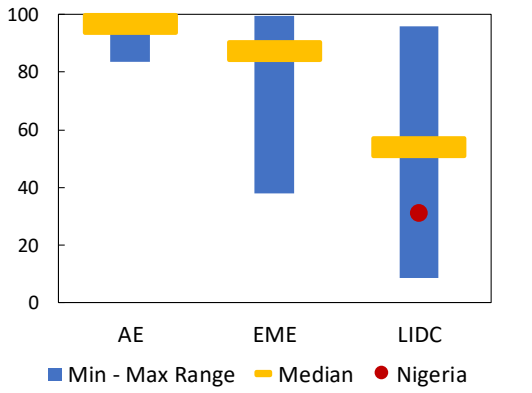
8. The lack of funding explains part of these deficiencies. While other factors—security, distrusts in government, access to other basic services—hinder outcomes, the resources devoted to education seem insufficient to deliver universal and high-quality education. At 1.6 percent of GDP, the combined spending on education by the public and private sectors is relatively low (Figure 3.a). School infrastructure is inadequate, and teachers lack materials. Most math and language teachers fail to achieve 80 percent in tests aimed at ten-year-old pupils.[8] Overall, Nigeria's score in the index used to measure education SDG performance falls far below the median for low-income and developing economies (Figure 3.b).

Figure 3. Education Inputs and Outcomes Comparison

a. Education Inputs



b. SDG4 Index, Nigeria, AE, EME, and LIDC



Source: IMF staff estimates using Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019): Sustainable Development Report 2019.
Note: Peers include Cameroon, Ghana, India, and Zimbabwe.

[6] African Development Bank, 2020, African Economic Outlook 2020.

[7] Nigeria Human Capital Index Country Brief, World Bank.

[8] Bold, T., and others, ,2019, The Lost Human Capital: Teacher Knowledge and Student Achievement in Africa; Bold, Tessa, and others, 2017, What do teachers know and do? Does it matter? World Bank, 2017.

9. To address these challenges and make meaningful progress toward SDG4, Nigeria would need substantial additional resources. To match the strong performers among Nigeria's peers, we estimate that total spending in education would need to increase by 7.7 percentage points of GDP by 2030 (Table 1). This reflects the need to boost enrollment, increase the share of capital in total spending, reduce class size, and raise teacher wages.

- *Increasing enrollment rates and improving infrastructure*. Nigeria could aim at raising enrollment to 80 percent of the school-age population by 2030, i.e., universal coverage for two years of pre-primary, full primary and secondary education, and two years of tertiary education.[9] To cope with higher enrollment—and refurbish current facilities—a larger share of the increase in education spending would need to be directed to infrastructure.

- *Increasing the quantity and quality of teachers*. While Nigeria has smaller class sizes than LIDC, we find that further reductions would be needed to match the student per teacher ratio of 16.5 in good performing countries today. This is particularly important in public schools which today have an average of 33 students per teacher. In addition, to attract more qualified teachers, the compensation of teachers would have to increase at a pace faster than GDP.

Table 1. Additional Spending for High Performance in Education SDG

	GDP per capita $0 - $3,000			Nigeria	
	All	Low performers	High performers	2018	2030
Main factors					
Students per teacher ratio	29.9	31.7	15.1	25.9	15.1
Teacher wages (ratio to GDP per capita)	2.8	3.7	2.1	1.2	2.1
Other current and capital spending (% total spending	43.9	43.5	55.0	24.5	39.8
Student age population (% total population)	56.9	57.7	39.2	51.0	50.4
Enrollment rate (preprimary to tertiary)	48.9	44.5	59.0	49.8	79.9
Results					
Education spending (percent of GDP)	4.7	5.4	7.2	1.6	9.3
Spending per student (USD 2019)	203.1	232.6	674.2	140.2	520.1

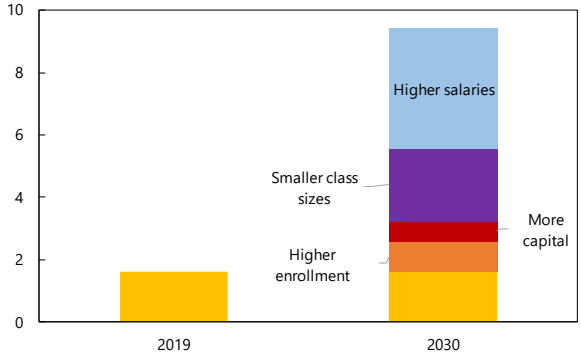
Source: IMF staff estimates.

10. A gradual and strategic approach should be considered given the relatively large additional spending. One priority is to increase enrollment rates. We estimate that, assuming the current level of spending per student, this increase in enrollment would require additional spending of 1 percentage points of GDP (Figure 4). This policy could be accompanied by larger commitments to school infrastructure, which would demand an additional 0.7 percentage points of GDP in spending. Smaller class sizes would require an additional 2.3 percentage points of GDP.

[9] We assume full enrollment in 2030 for at least two years of preprimary and tertiary education and 12 years of primary and secondary education. I.e., the target enrollment rates are 50 percent for preprimary and tertiary, and 100 percent for primary and secondary. Overall, the targeted enrollment rate is 80 percent (16 years/20 years).

Finally, higher wages to attract qualified teachers, would require an additional 3.9 percentage points of GDP.

Figure 4. Decomposition of Additional Spending in Education for SDG4



Source: IMF staff calculations.

11. Beyond resources, it is critical to address disparities across genders, regions and public and private services. An equitable education system has positive effects on economic growth, helps alleviate poverty, and improve income distribution in the medium term.[10]

- Disparities remain between the education received by girls and boys.[11] By ensuring equal educational opportunities to all children, regardless of gender, Nigeria could boost economic growth. For example, increasing the share of women with secondary education by one percentage point will boost annual per capita growth by 0.3 percentage points.[12]
- Geographical disparities in outcomes are significant, driven by various factors, including security, economic barriers and low trust in formal education in some areas, especially for girls.[13] While 78 percent of Southwest children can read part or whole sentences, only 17 percent of Northeast children are able to do so.[14] Addressing these gaps in access is critical for economic growth—for every nine children, five live in the North.
- Disparities between public and private schools have been documented in terms of class size, teacher's quality, adequacy of facilities, curriculum practices, stability of academic activities.[15]

[10] UNICEF, 2007, "A human rights-based approach to education for all: A framework for the realization of children's right to education and rights within education".

[11] Favara, M., Appasamy, I., and Garcia, M., 2015, Nigeria: Skills for Competitiveness and Employability. World Bank.

[12] Klasen, S. (2002). Low schooling for girls, slower growth for all? Cross-country evidence on the effect of gender inequality in education on economic development. The World Bank Economic Review, 16(3), pp. 345–73

[13] UNICEF Education Program in Nigeria.

[14] Onwuameze, N. C. (2013). Educational opportunity and inequality in Nigeria: assessing social background, gender and regional effects

[15] Adebayo, F. A. (2009). Parents' preference for private secondary schools in Nigeria. International Journal of Educational Sciences, 1(1), pp. 1–6.

Narrowing these gaps, particularly in primary and secondary education, could improve opportunities for the most vulnerable. In the medium-term, addressing these inequities would also help reducing the relatively high level of private spending in education.

12. Nigeria made progress on its information system, but more efforts are needed. Detailed information on the number of students, teachers, and schools is available, but little is known about the spending on education by the different government levels or the private expenditure on education.[16] Much less is known at the school level. To support decision-making based on evidence, one priority is to collect spending data linking it to the provision of education services. For example, includes spending per capita and outcomes by region would help to inform best practices and better target scarce resources.

B. Health

13. Nigeria has made some strides in health outcomes yet lags far behind peers. Mortality rates of children under five years old dropped from 211 to 120 deaths per 1,000 live births in 1990–2018, a 60 percent reduction (Figure 5.a). Progress has also been made in maternal mortality, which declined by 24 percent from 1990 to 2018. Yet, health outcomes lag those in countries with comparable per capita income (Figure 5.b). Across indicators, Nigeria fares poorly. Infant mortality is the third highest in the world, far higher than countries with lower income per capita. Healthy life expectancy is just 49 years, placing Nigeria among the bottom six countries in the world. With a disproportionate share of out-of-pocket health expenditures—about 70 percent of the health expenditures—most households are financially vulnerable to health shocks. The World Health Organization ranks Nigeria's healthcare system at 187 among 190 countries.[17]

14. Health care spending is inefficient. Overall, Nigeria's score in the index used to measure health SDG performance falls far below the median for low-income economies (Figure 6.a).[18] This low performance, however, does not seem to be explained by the level of spending. At 4 percent, the share of the GDP devoted to health in Nigeria is shy of that in India, Ghana, and Cameroon—countries with substantially better outcomes—albeit lower than the median for low income and developing countries (Figure 6.b). In Purchased Power Parity dollars, Nigeria spends more on health per person than other low-income economies (Figure 6.c). At this level of spending per capita, Nigeria could achieve substantially better outcomes. In many

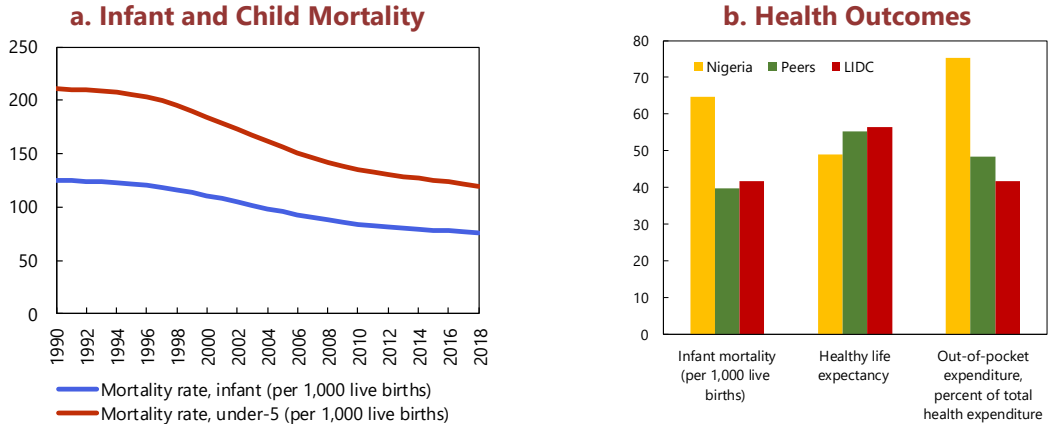
[16] World Bank Group, 2015, "Nigeria Partnership for Education Project". World Bank.

[17] Tandon, A., Murray, C. J., Lauer, J. A., & Evans, D. B., 2000, "Measuring overall health system performance for 191 countries." World Health Organization.

[18] The SDG3 index comprises 14 variables: maternal, neonatal, and under-5 mortality rates; incidence of tuberculosis; new HIV infections; death rates from: selected noncommunicable diseases, air pollution, and traffic accidents; life expectancy; adolescent fertility rate; professionally attended births; vaccination rates; and the Tracer index; and a subjective wellbeing measure. See Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019). Sustainable Development Report 2019.

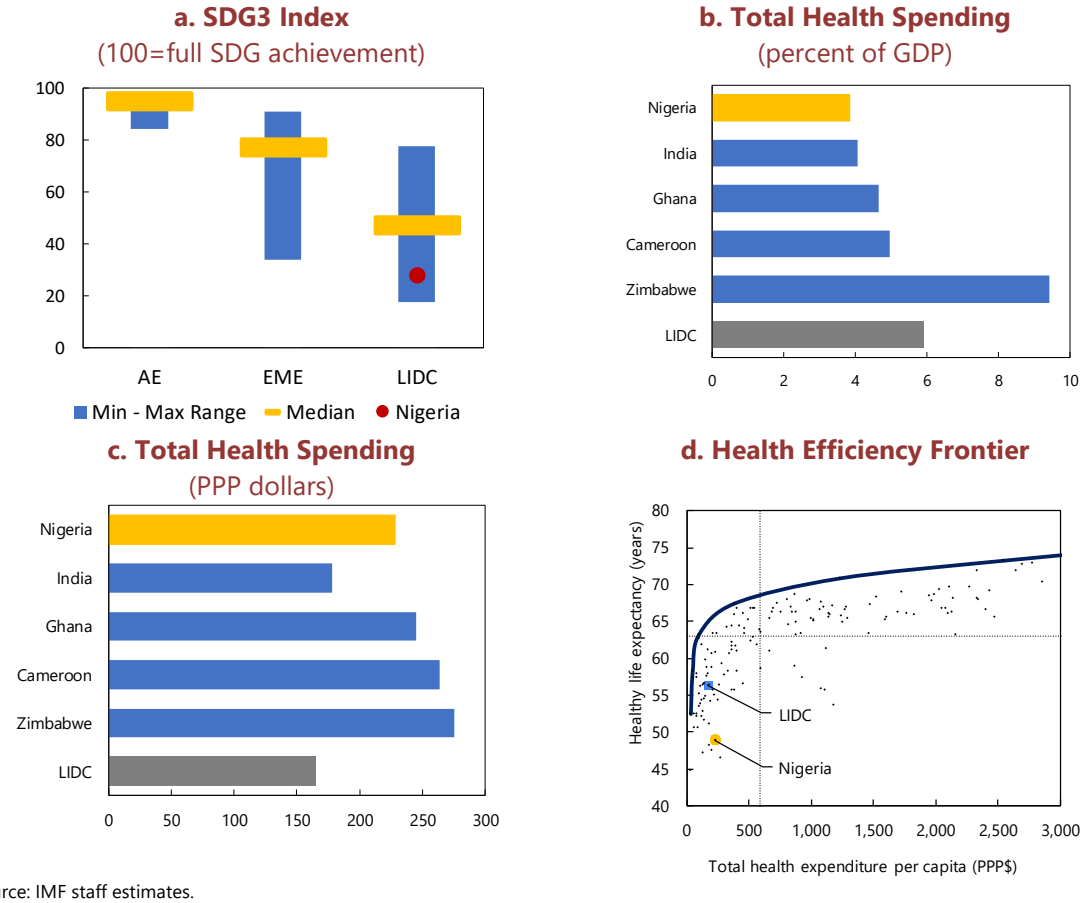
countries, including Angola, Kenya, Rwanda, and Senegal, spending per capita is lower yet healthy life expectancy is substantially higher than in Nigeria (Figure 6.d).

Figure 5. Health Outcomes



Sources: IMF FAD Expenditure Assessment Tool; World Development Indicators.
Note: Peers include Cameroon, Ghana, India, and Zimbabwe.

Figure 6. Performance in the Health SDG, in Income-Group and Regional Comparison



Source: IMF staff estimates.
Note: In panel d, the dotted lines show the averages for countries with GPD per capita under $3,000. Healthy life expectancy computes the number of years of life expected to be lived in full health.

15. Addressing inefficiencies while increasing spending would be needed to make significant progress in the health SDGs. Under the current resource envelope, addressing inefficiencies should remain a priority—Nigeria should be delivering outcomes commensurate to its current level of spending. Nevertheless, in the medium-term, we estimate that more resources would be needed, including raising the share of health care workers in the population. We estimate to replicate the input/output mix in the good performers among peer countries today, Nigeria would need to increase health expenditure by 4.3 percentage points of GDP between now and 2030 (Table 2).

- *Raising the number of health workers*. To reach the standards of well performing countries, the number of doctors per 1,000 population needs to increase from 0.2 to 0.4 while the number of other health personnel per 1,000 population needs to increase from 2 to 4.

- *Making wages more competitive.* At 6 times GDP per capita, doctors' wages are low in GDP per capita terms relative to strong performers. There is scope to raise wages in the health sector at a faster pace than GDP growth, albeit gradually. This could contribute in reducing pressures for Nigerian doctors to migrate abroad.[19]

Table 2. Estimated Spending Needed for High Performance in Health SDG

	GDP per capita Below $3,000			Nigeria	
	All	Low performers	High performers	2017	2030
Main factors					
Doctors per 1,000 population	0.1	0.1	0.9	0.2	0.9
Other medical personnel per 1,000 population	1.5	1.3	4.3	2.0	4.1
Share of population 0-1 and 60 and older	8.2	8.1	10.2	8.5	8.0
Doctors per 1,000 population age 1-59	0.1	0.1	0.8	0.2	0.8
Other medical personnel per 1,000 population age 1-59	1.22	1.1	3.5	2.2	3.5
Doctor wages (ratio to GDP per capita)	19.8	22.8	10.4	5.9	10.4
Other current and capital spending (% total spending)	70.0	70.0	62.3	82.0	62.3
Results					
Health spending (percent of GDP)	6.0	5.6	7.6	3.8	8.1
Per capita spending (USD 2018)	66.4	52.9	165.1	85.3	181.4

Source: IMF staff estimates.

16. A rebalancing of the system, with the government playing a larger role in financing primary care seems necessary. The combined spending in health by the government (federal, state, and local) is just 0.6 percent of GDP. Over 85 percent of total health expenditures come from the private sector, of which the majority corresponds to out-of-pocket payments from

[19] Since 2005, 18,949 doctors (43 percent of the doctors in 2018) have applied for a verification of standing letter (i.e., a proxy of migration).

households.[20] This stands in contrast to the strong performing countries, whose median private share in health spending is 48 percent. The reliance on payments at the point of service is a high barrier to access health care for many and leads to more expensive care for both the patient and the system.[21] Catastrophic health events result in substantial loss of income for many families, with an additional 3.5 percent of the population falling into poverty every year.[22] This suggests ample scope for government interventions geared at expanding affordable access to health care for the most vulnerable. A starting point could be to strengthen the primary health care network, which can be effective in improving health care outcomes.[23] The government had set a medium-term plan to reduce the financial barriers to accessing the healthcare system.[24]

17. Plans toward a universal health care insurance seem promising, but more political commitment is needed. Nigeria's insurance system is available only for formal workers.[25] Steps to expand access to insurance have been taken in the past few years. The National Health Act of 2014 established the legal framework for the creation and functioning of the Basic Health Care Provision Fund, which aims at providing financing for the most vulnerable to access to basic care.[26] However, more political and budgetary commitments are needed—the resources allocated to the fund thus far have been minimal.

18. Beyond financing, weaknesses in governance and financial management could be addressed. Responsibilities for health care are shared across all layers of government—about one-third of public spending is carried by subnational governments. This allows for the localities to attend their constituencies in a direct way. The shared responsibilities, however, raise the need for coordination to prevent inefficiencies in the use of government resources and attend regional disparities. And the large footprint of the private sector in health care means that coordination should go beyond government resources. The adoption of the SDGs in national development plans provides an enormous opportunity for greater coordinating in public and private efforts in improving the health outcomes of Nigerians. Beyond a few programs and interventions that cross across governments, a global approach is needed in linking the overall health strategy with the total resource envelope available for health care.

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[20] National Population Commission and ICF. 2019. Nigeria Demographic and Health Survey 2018.

[21] Pan American Health Organization and World Health Organization. 2017. Health Financing in the Americas.

[22] World Bank and World Health Organization, 2019. Global Monitoring Report on Financial Protection in Health.

[23] World Health Organization. (2018). A vision for primary health care in the 21st century: towards universal health coverage and the Sustainable Development Goals (No. WHO/HIS/SDS/2018.15). World Health Organization.

[24] In the Second National Strategic Health Development Plan (NSHDP II), one of the pillars is setting up actions to expand coverage and reduce financial barriers through social health insurance and improving government funding to the health sector.

[25] World Bank, 2018, Nigeria Health Financing System Assessment; World Bank, 2020, Advancing Social Protection in a Dynamic Nigeria.

[26] Hafez, R. (2018). Nigeria Health Financing System Assessment. World Bank.

III. PHYSICAL CAPITAL

A. Electricity

19. The share of the population with electricity access increased from 40 percent in 2015 to 54 percent in 2020.[27] During the same period, the installed available generation capacity connected to the grid increased from 4,000MW to 7,500MW, the nominal transmission capacity increased from 5,000MW to 8,000MW, and the dispatch capacity increased from 3,500MW to 5,500MW.[28] The Nigerian Rural Electrification Agency (REA)—tasked with electrification of rural and unserved communities—connected about 100,000 households, impacting 500,000 people and providing more than 5,000 jobs.[29] In 2019, the number of total system collapse was reduced to 10, down from an average of 15 per year in 2010–18.[30]

20. Nigeria's electricity consumption amounts to about half of what would be expected at its current level of GDP per capita. The electricity supply chain—generation, transmission, and distribution—faces substantial challenges due to years of underinvestment. Only 7,500MW of the 13,500MW on-grid installed generation capacity is functional. Transmission is the system's bottleneck, dispatching 50 percent below its nominal capacity—less than 4,000MW is end-to-end operational through the grid. Of this, about 10 percent of on-grid electricity demand is unmet. Deficient on-grid supply forces consumers into costly off-grid alternatives, which account for 52 percent of electricity consumption.[31] Accounting for on- and off-grid provision, the electricity consumption per capita of 348kWh is below peers (Figures 7 and 8).[32]

[27] Data provided by the Nigeria's Federal Ministry of Power.

[28] Sustainable Development Goal No. 7 (SDG7)-Electricity Progress and Priorities in Nigeria, presented by Engr. Faruk Yusuf Yabo, Ag. Director – Renewable Energy & Rural Power Access (RRD), on 31st January 2020 at the meeting with IMF team.

[29] See: "The Rural Electrification Agency's Impact Report," available at https://rea.gov.ng/rural-electrification-agencys-impact-report/.

[30] Data provided by the Nigeria's Transmission Services Department: "Outcomes and Performance Metrics for the year 2019."

[31] Individuals consider off-grid electricity provision as inadequate and seem to favor on-grid provision (Leo, Ben, Jared Kalow, and Todd Moss, 2018, "What Can We Learn about Energy Access and Demand from Mobile-Phone Surveys? Nine Findings from Twelve African Countries," Centre for Global Development).

[32] The electricity consumption per capita in 2019 of 348kWh was estimated as follows: actual 151.9kWh on-grid consumption + 10 percent unmet demand divided by 48 percent on-grid capacity (i.e., 151.9kWh x 1.1 / 0.48 = 348kWh). This reflects what on-grid demand would have been should the systems have properly worked.

Figure 7. Electricity Consumption per Capita
(kWh in 2019 or latest year)

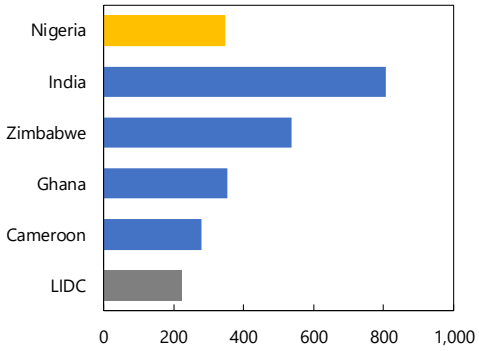
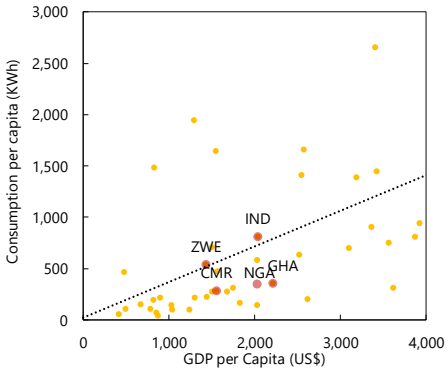


Figure 8. Income and Electricity Consumption



Source: IMF staff calculations based on data from the World Bank.

21. Large investments are needed in the power sector to increase access and keep up with population growth. Between 2018 and 2030, the population is projected to increase from 196 to 263 million. In this period, GDP per capita in U.S. dollars is projected to increase marginally. Electricity consumption per capita is estimated to grow from 348 kWh in 2019 to 635 kWh by 2030 driven by increased access (Figure 9). To expand installed capacity by 22.4GW, at a unit cost of US$2,184 per kW (including generation, transmission, and distribution costs), Nigeria will have to invest an aggregate of US$49 billion in 2020–30, which on an annual basis is equivalent to 1 percent of GDP, including replacement costs (Table 3).[33]

Figure 9. Economic and Electric Power Consumption Statistics

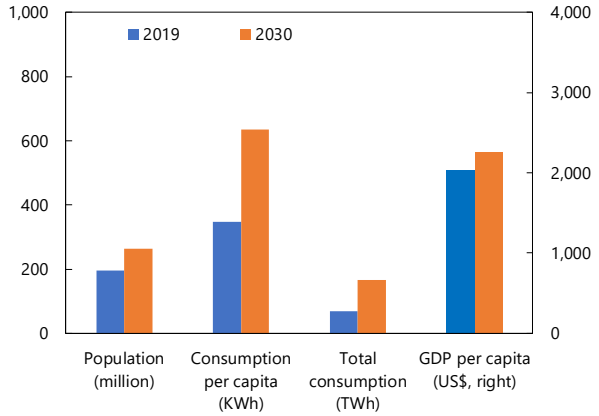


Table 3. Additional Investment in Electric Power Capacity Requirements

A. Additional consumption (TWh)	137
B. Additional capacity (GW) (A ÷ (hours per year × 70 percent factor))	22
C. Unit cost incl. generation, transmission and distribution (US$ per kW)	2,184
D. Total investment (US$ billion) (B x C)	49
E. Total annual investment plus depreciation (percent of annual GDP)	1.0

Source: IMF staff calculations.
Note: The cost of meeting electric power demand is calculated as a function of increased access, GDP per capita growth, investment cost per additional kW (including generation, transmition, and distribution), and replacement costs. The capacity factor of 70 percent reflects the safety capacity needed to meet pick demand and avoid unmet demand and blockouts.

[33] See Appendix III for the details on the calculation of investment costs in generation, transmission, and distribution of electric power per kW.

22. In the short term, efforts to rehabilitate and upgrade generation and transmission capacity should be a priority. The Transmission Company of Nigeria is aiming at stabilizing the grid, coordinating procurement and investment, and closing the gap between demand and supply. The Federal Government of Nigeria and Siemens recently signed an implementation agreement for the Nigeria Electrification Roadmap.[34] As a first step, rehabilitating the existing infrastructure can boost end-to-end capacity to 7,000 MW. Solving network bottlenecks will enable full use of existing generation and distribution capacities, bringing the systems operational capacity to 11,000 MW. Finally, the plan includes upgrades and expansions in generation, transmission, and distribution to 25,000 MW. Rehabilitating and upgrading the existing capacity could be a cost-efficient way of meeting part of the required investment to meet electricity demand.

23. The Sustainable Energy for All (SE4ALL) program envisions the increase in renewable sources in the energy mix. Nigeria is among the top 50 CO_2 emitters.[35] The government plans to increase capacity in a more sustainable way. The SE4ALL program encompasses the Vision 30-30-30—i.e., boosting capacity to over 30GW with a share from renewable sources of 30 percent by 2030 (Table 4).[36]

24. Mini-grids can play an important complementary role. Nigeria presents excellent conditions for sustainable solar energy generation. Mini-grid sustainable solutions can complement the capacity supply in the lack of on-grid provision. Mini-grids can quickly mobilize scalable capacity and provide electricity to remote and vulnerable communities. The Rural Electrification Agency (REA) is defining the terms and standards for 250 new mini-grids in the country, while the World Bank and the European Union provide financing to its development.[37]

25. Reforming the electricity sector can have a large impact on equitable access. Increasing affordable electricity access can have positive effects on the most vulnerable. Off-grid electricity provision comes at cost to final consumers. For example, low-income households regularly dedicate 9 percent of their expenditures to energy (e.g., charging cell phones in kiosks with a kerosene generator for a fee).[38] Also, a significant share of income is spent by off-grid households on candles and fuel lamps.

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[34] See: https://press.siemens.com/global/en/pressrelease/siemens-and-nigerian-government-signed-implementation-agreement-electrification.

[35] See: hhttps://www.worldometers.info/co2-emissions/.

[36] See: http://www.se4all.ecreee.org/sites/default/files/nigeria_se4all_action_agenda-energy_mix_chart.pdf.

[37] See, e.g.: https://www.pv-magazine.com/2019/10/07/world-bank-nigerias-mini-grid-sector-set-to-boom/; https://ec.europa.eu/commission/news/bringing-reliable-electricity-rural-communities-nigeria-2019-jul-03_en; https://allafrica.com/stories/201806040029.html

[38] GSM Association. (2011). Community Power from Mobile-Charging Services. GSM Association. Accessible at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/charging_services.pdf.

Table 4. Current and Target On-Grid Capacity Mix

Source		2016 MW	2016 Percent	2030 MW	2030 Percent
Conventional	Gas	3,121	71	13,000	41
	Coal	0	0	3,200	10
	Nuclear	0	0	2,000	6
	Sub-total conventional	3,121	71	18,200	57
Renewable	Large Hydro Plants	1,200	27	4,700	15
	Small Hydro Power	45	1	1,200	4
	Solar PV	0	0	5,000	16
	Solar Thermal	0	0	1,000	3
	Wind Power	10	0	800	3
	Biomass	0	0	1,100	3
	Sub-total w LHP	1,255	29	13,800	43
	Sub-total w/o LHP	55	1	9,100	28
Total		**4,376**	**100**	**32,000**	**100**

Source: IMF staff calculations using the "Sustainable Energy for All Action Agenda (SE4ALL-AA)" (2016), National Council on Power, Federal Republic of Nigeria.
Note: The cost of installed capacity per MW is calculated as the weighted average by type of source. The cost of generation and distribution is assumed to be 50 percent of generation cost each.

B. Roads

26. The current administration has made significant investment in road infrastructure; nonetheless, a large proportion of Nigeria's 195,000 road network is in unsatisfactory condition due to insufficient maintenance.[39] The World Bank estimates that about 16 percent of the roads are federal, 16 percent of state, and 68 percent of rural.[40] While no reliable government assessment of the road network quality is available, the condition of many roads seems deficient (Figure 10).[41]

27. Only 26 percent of Nigeria's rural population have access to all-weather roads within two kilometers (Figure 11). Nigeria's road density is low in comparison to other countries. Nigeria's 22 km per 100 square km is below India (208 km per 100 square km), a country with a similar per capita GDP. Southern states have relatively higher accessibility than the Northern states. In 2014, the Rural Access Index (RAI) of Imo State was significantly higher (50 percent) than Adamawa State (12.8 percent).[42]

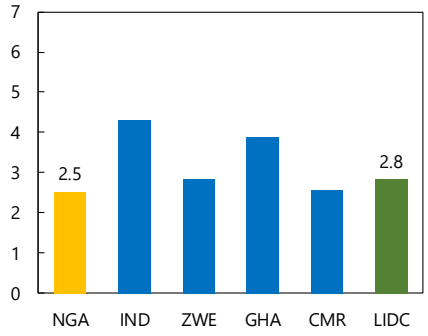
[39] Melorose, J., Perroy, R., and Careas, S. (2015). An Infrastructure Action Plan for Nigeria: Closing the Infrastructure Gap and Accelerating Economic Transformation. African Development Bank Group.

[40] See: https://www.icrc.gov.ng/135000km-road-network-nigeria-un-tarred-icrc/.

[41] World Bank (2019). "Nigeria Transport Issue Paper #5: Federal Roads."

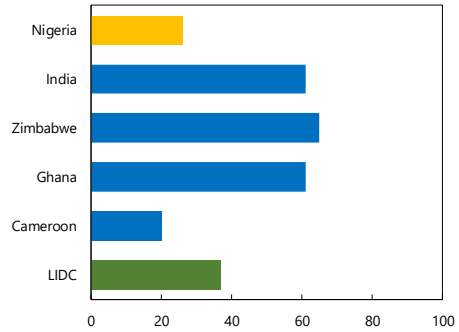
[42] World Bank (2019). "Nigeria Transport Issue Paper #3: Rural Access."

Figure 10. Quality of Roads Perception
(1=extremely poor to 7=extremely good)



Source: World Economic Forum, 2019, The Global Competitiveness Report 2019.

Figure 11. Rural Access Index
(percent of rural population with access to roads within two kilometers)



Source: The World Bank, Measuring Rural Access: Update 2017/18, February 2019 and Mikou, M., Rozenberg, J., Koks, E. E., Fox, C. J. E., and Peralta Quiros, T. (2019). Assessing Rural Accessibility and Rural Roads Investment Needs Using Open Source Data. The World Bank, Policy Research Working Paper 8746.

28. Nigeria will have to invest a significant share of its GDP to improve road access. While construction costs vary by type (i.e., number of lanes and type of surface) and region, we estimate an average cost per kilometer of about US$550 thousand. Thus, extending the road network by nearly 180 thousand kilometers will require an aggregate investment of almost US$100 billion over 2020–30, which on an annual basis is equivalent to 2 percent of GDP, including depreciation (Figure 12 and Table 5). Furthermore, we estimate that, on top of the 2 percent of GDP per year on new road infrastructure, Nigeria will have to invest at least up to 0.5 percent of GDP per year in refurbishing and modernizing its existing road infrastructure.

Figure 12. Main Road Statistics

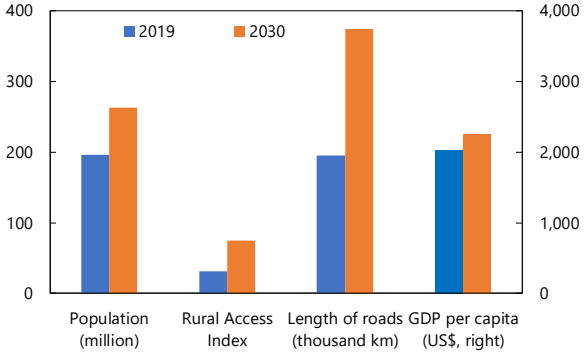


Table 5. Additional Investment in Roads

A. Additional roads (thousand km)	179
B. Unit cost (US$/km)	550,000
A*B= Total investment (US$ billion)	99
Total annual investment plus depreciation (percent of GDP)	2.0

Source: IMF staff calculations.
Note: See Appendix IV for a calculation of road length needed in 2030.

29. The institutional governance of the road network could be strengthened. Crossing competences between government levels (i.e., federal, state, and local administrations) and functional competences within administrations (i.e., ministries, department, and agencies) impose coordination challenges.

- *Partnerships with the private sector need scrutiny to ensure value for money*. The government is championing solutions with the private sector as a key player in the development of road infrastructure. While these partnerships can encourage private funding, without a strong institutional regulatory setup they may exacerbate governance problems. For example, road-for-taxes programs could be used to bypass budgetary scrutiny.

- *Scope for greater coordination.* Road construction has been largely driven by *ad-hoc* programs with little prioritization. Appropriations for road construction lack funding, resulting in unfinished works and poor maintenance. At minimum, the federal government could take the leadership in outlining a national network with consideration of increasing maintenance of existing road assets as well as enhancing monitoring and accountability of ongoing projects.

C. Water and Sanitation

30. Nigeria has made some recent progress in water and sanitation provision. Water and sanitation indicators worsened in the 1990s and 2000s, reflecting years of poor maintenance and low investments in water and sanitation assets.[43] Partly because of this neglect, the current federal administration declared a state of emergency in water and sanitation. The gradient of progress has been noticeable. Between 2010 and 2018, access to basic sanitation increased from 32 to 42 percent of the population, an achievement given the rapid population growth. In the same period, access to basic water increased from 79 to 87 percent of the urban population and from 46 to 60 percent of the rural population.

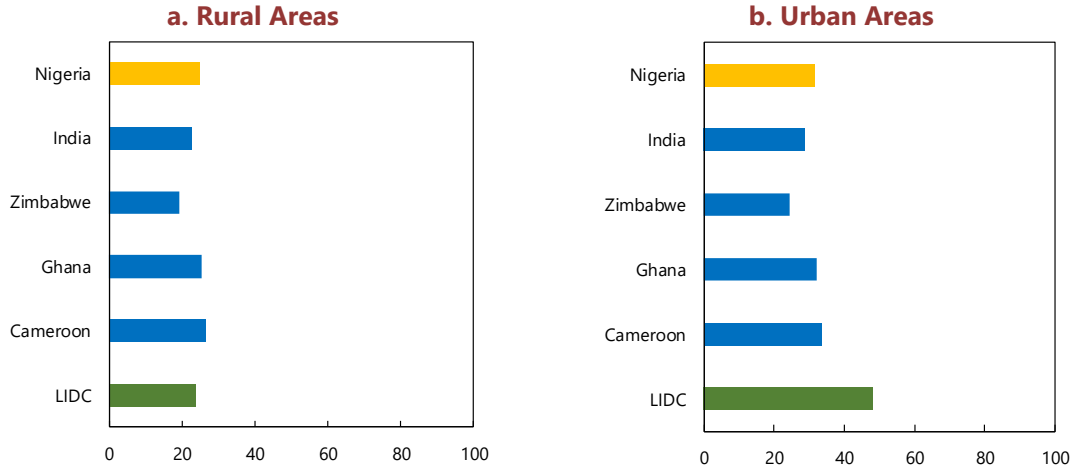
31. Yet substantial challenges remain. 47 million people still practice open defection. A third of the population do not have access to basic water services. Access to basic and safely managed sanitation services is even lower (Figures 13). Only 3.7 percent have access to safely managed water services (Figures 14). These deficiencies are higher in rural than urban areas, with disparities across regions and wealth quintiles (Figure 15).[44] For example, access to basic water and sanitation is above 50 percent of the population in Anambra and Imo and below 10 percent of the population in Borno and Ebonyi. The federal government is making efforts to coordinate programs effectively and co-share expenses with the states through targeted programs.

[43] World Bank. 2017. *A Wake-Up Call: Nigeria Water Supply, Sanitation, and Hygiene Poverty Diagnostic*. WASH Poverty Diagnostic. World Bank, Washington, DC.

[44] Joseph-Raji, Gloria and others, 2019. Nigeria Biannual Economic Update: Water Supply, Sanitation and Hygiene – A Wake-up Call. World Bank.

Figure 13. Access to Safely Managed Sanitation

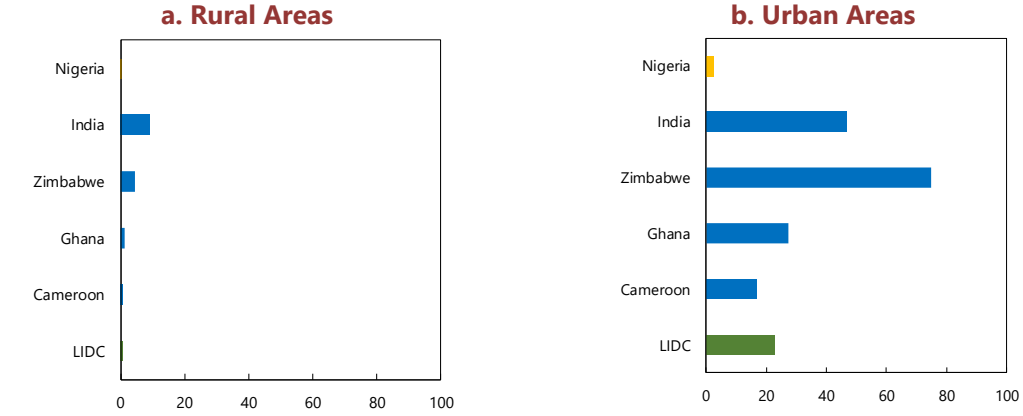
(Percent of population)



Source: IMF staff calculations based on data from the World Bank.

Figure 14. Access to Safely Managed Water

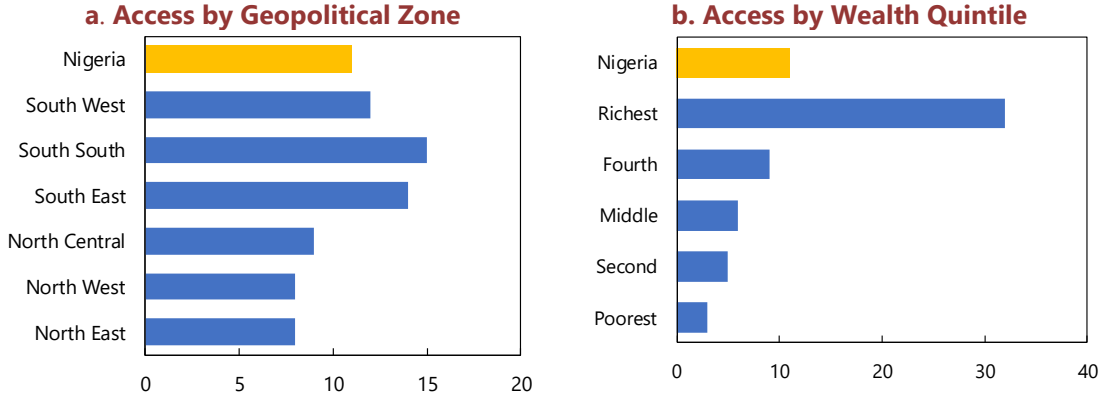
(Percent of population)



Source: IMF staff calculations based on data from the World Bank.

Figure 15. Access to Basic Water and Sanitation Services

(Percent of population)



Source: "National Outcome Routine Mapping of Water, Sanitation and Hygiene Service Levels—Nigeria. Summary of Survey Findings 2018." National Bureau of Statistics, Nigeria, in collaboration with the European Union, UKaid, the World Bank, and UNICEF.

32. The government is prioritizing efforts and setting achievable goals. The authorities are committed to end open defecation by 2025.[45] The campaign *"Clean Nigeria: Use the Toilet"* launched in 2019 is based on dissemination of technical instructions for the construction of toilets and behavioral nudging aimed at sensitizing the population and mobilizing public and private resources. The program identifies the location, resources needed (US$2.7 billion), and responsibility (75 percent households, 25 percent government and PPPs) for the construction of 20 million toilets (Table 6). Following WHO recommendations, the government is taking a gradual approach to close the gap by reducing the distance to basic water and sanitation services from 30 to 15 minutes roundtrip. [46]

Table 6. Targets and Estimated Budget in the "Clean Nigeria: Use the Toilet" Campaign

Location	Number of toilets required (thousand)	Unit cost (US$)	Total cost (US$ million)	Responsibility
Urban households	7,500	150	1,125	Households
Rural households	12,500	70	875	Households
Schools	39	4,200	160	Government
Primary health care centers	2	2,100	5	Government
Market	2	15,000	22	Government/PPP
Motor parks	0.2	15,000	3	Government/PPP
Software component (capacity building, sensitization/adv. triggering, etc.)			460	Government
Total	20,043	109	2,650	

Source: Federal Ministry of Water Resources and IMF calculations.

33. Nigeria can achieve high-impact basic coverage of water and sanitation at a moderate cost. We estimate the cost to provide universal safely managed access to water and sanitation following the World Bank's methodology.[47] Overall, meeting basic water and sanitation needs will require an aggregate of US$23 billion over 2020–30, i.e., only 0.55 percent of annual GDP including depreciation (Table 7).[48] Providing safely-managed water and sanitation will require an additional 2.5 percent of annual GDP, including depreciation.

34. Making substantial progress in the water and sanitation SDG can have a positive impact on equity. The World Bank estimates that annual losses from poor sanitation—access

[45] See: "Making Nigeria Open-Defecation Free by 2025—A National Road Map" (2016). Federal Ministry of Water Resources, in collaboration with the European Union, Kuai, and UNICEF.

[46] See: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3180744/.

[47] Hutton and Varughese, 2016, The costs of meeting the 2030 sustainable development goal targets on drinking water sanitation, and hygiene. Water and Sanitation Program technical paper.

[48] See also Hutton, G., & Varughese, M. (2016). The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water. Sanitation, and Hygiene. World Bank.

time, premature death, productivity losses, and healthcare—are equivalent to 1.3 percent of GDP per year.[49] These costs tend to be higher for the most vulnerable. Improving water and sanitation systems, although initially costly in fixed costs, would have a positive impact on the poor. For example, ending open defecation could cut the time spent finding a private location to defecate (estimated at about 2.5 days a year).

35. Beyond mobilizing financial resources, institutional and technical capacity constraints need to be addressed.[50] The amount of resources and skilled labor required to address the construction of toilets, pipes, and facilities are large. On the other hand, these needs are likely to create business and employment opportunities, particularly in rural areas, attracting capital and skilled labor.

Table 7. Additional Investment in Water and Sanitation

	Ending open defecation	Basic						Safely Managed				Total
		Water		Sanitation		Hygiene		Water		Sanitation		
		Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	
Total population (2019)	196	97	99	97	99	97	99	97	99	97	99	196
Total target population (million)	56.3	43	20	67	78	88	114	104	151	88	132	255
Population unserved in 2019 (million)	47.0	39	13	60	49	80	72	94	94	78	75	188
Population growth 2019-2030 (million)	9.3	4	7	6	29	8	42	10	57	10	57	67
Cost (per capita, US$)	15.3	79	79	90	90	19	19	156	468	60	179	530
Total cost (US$ million)	860	3,389	1,597	5,979	6,994	1,650	2,131	16,291	70,605	5,246	23,563	135,381
Annual cost (US$ million)	108.2	326	154	576	673	159	205	1,446	6,269	466	2,092	12,180
Total cost (percent of 2030 GDP)	0.1	0.57	0.27	1.01	1.18	0.28	0.36	2.75	11.92	0.89	3.98	22.9
Annual cost (percent of annual GDP)	0.0	0.08	0.04	0.14	0.17	0.04	0.05	0.36	1.57	0.12	0.53	3.1

Source: IMF staff calculations, based on 2018 WASH NORM and 2016/2017 MICS reports.
Note: The methodology follows Hutton and Varughese (2016) and accounts for GDP growth and depreciation.
Rural and urban cost per capita are assumed to be similar for basic services, and urban cost per capita are assumed to be three times larger than in rural areas for safely-managed services. Depreciation rate is assumed to be the inverse of seven years for basic toilets, 12 years for basic services, and 15 years for safely-managed services.

[49] Water and Sanitation Program, 2012. Economic Impacts of Poor Sanitation in Africa.

[50] Akpabio, E. M., 2012, Water supply and sanitation services sector in Nigeria: the policy trend and practice constraints (No. 96). ZEF Working Paper Series.

Appendix I. Education

The SDG costing estimate for education is expressed as the additional spending needed to perform well in the education SDG, that is, the difference between the spending needed in 2030 and the spending level today. Both today's education expenditures (as a percent of GDP), E^{2018}, and the levels needed by 2030, E^{2030}, are expressed as an identity:

$$E = \frac{w}{STR} e \frac{SAP}{100 - E^{oth}}$$

where *w* refers to teachers' annual wages as a ratio to GDP per capita, *STR* is the student teacher ratio, *e* signifies the enrollment rate, i.e. the number of students as a percentage of the student-age population, *SAP* indicates the student-age population as a percent of total population, and E^{oth}, pertains to all education spending besides the teacher wage bill as a percent of total expenditures in education.

The spending needed in 2030 to perform well in the education SDG is the level of expenditures Nigeria would incur by 2030 due to projected demographics (student-age population) and if it matched, by 2030, today's levels of the education cost-drivers of the high performers among Nigeria's peers. These cost drivers include teachers' wages, the student-teacher ratio, the enrollment rate, and education spending other than the teacher wage bill. The approach of matching Nigeria's 2030 cost drivers to today's level of the high performers is seen in the corresponding columns of Table 2. Table AI.1 gives the data sources and computation of demographic factors and cost drivers (latest estimates available are for 2017–18).

Table AI.1. Computation and Data Sources for Variables Used in the Education SDG Costing Estimation

Variable	Computation, or data source	Value
STR	[number of students] / [number of teachers]	25.9
Number of students	Received from authorities (Nigeria Digest of Education Statistics, 2017)	48,403,623
Number of teachers	Received from authorities (Nigeria Digest of Education Statistics, 2017)	1,866,870
E^{oth}	In government education: ⟨ [total spending] – [teachers wage bill]⟩ / [total spending]	0.25
Personnel wage bill (in Nairas)	0.9* [Recurrent total spending] (assumption that 90% of recurrent expenditures goes to personnel wage bill)	1,482,412,193,703
Teachers wage bill (in Nairas)	Number of teachers * *w*	1,241,520,212,226
SAP	[population aged 2–21] / [total population]	0.51

Variable	Computation, or data source	Value
Population aged 2–21	UN (2019)	97,331,794
Total population	UN (2019)	190,873,244
e	[number of students] / [population aged 1-21]	0.50
E	In education: { [public spending] + [private spending] } / GDP	1.6
Public spending (In Nairas.)	In government education: [total spending] Data source: Central Bank of Nigeria, 2017 Annual Report	1,153,050,161,511
Private spending (In Nairas.)	Private education spending in levels: Public Spending*[private education proportion]/[1- private education proportion]	691,830,096,907
Private education proportion of total expenditures)	From the Africa Economic Outlook, 2020 – African Development Bank	0.375
w	Level of teacher wages (as ratio of GDP per capita) that satisfies $E = \frac{w}{STR} e \frac{SAP}{100 - E^{oth}}$	1.2

Appendix II. Health Care

The SDG costing estimate for health is expressed, analogous to that for education, as the additional spending needed to perform well in the health SDG, that is, the difference between the spending needed in 2030 and the spending level today.

Both today's health expenditures (as a percent of GDP), E^{2018}, and the levels needed by 2030, E^{2030}, are expressed as an identity:

$$E = 10w\frac{D + 0.5M}{100 - E^{oth}}$$

where *w* refers to doctors' annual wages as a ratio to GDP per capita, *D* and *M* are the numbers of doctors and other medical personnel, respectively, per 1,000 population, and E^{oth} pertains to all spending besides the health workers' wage bill as a percent of total expenditures in education.

The spending needed in 2030 to perform well in the health SDG are the level of expenditures Nigeria would incur by 2030 in light of projected demographics (the projected population share of infants and the elderly, who have greater medical needs) and if it matched, by 2030, today's levels of the health cost-drivers of the high performers among Nigeria's peers. These cost drivers include doctors' wages, the number of doctors relative to the population size, the number of other medical personnel relative to the population size, and health spending besides the health workers' wage bill. The approach of matching Nigeria's 2030 cost drivers to today's level of the high performers is seen in the corresponding columns of Table 2. Table AII.1 gives the data sources and computation of demographic factors and cost drivers for Nigeria in today (latest estimates available are from 2016–17).

Table AII.1. Computation and Data Sources for Variables Used in Health SDG Costing Estimation

Variable	Computation, or data source	Value
D	1000* [number of doctors] / [population]	0.21
Number of doctors	Received from authorities (Nigeria Health Workforce Country Profile 2018)	39,388
Population	UN (2019): "World Population Prospects", Population Division, Department of Economic and Social Affairs, United Nations	186,725,399
M	1000* [number of registered other medical staff] / [population]	1.97
Number of registered other medical staff	Received from authorities (Nigeria Health Workforce Country Profile 2018)	367,020

Variable	Computation, or data source	Value
E^{oth}	In government health: 〈 [total spending] – {[compensation of employees, non-administrative] 〉/ [total spending]	0.82
Personnel wage bill (in Nairas)	0.22* [current health spending] (We assume the spending on non-specified factor follows the same distribution as the expenditures tracked to a specific factor. From National Health Accounts 2010–16)	819,857,526,048
Health care professionals wage bill (in Nairas)	0.87* [Personnel wage bill] (assumption that 87% of personnel wage bill goes to health care professionals wage bill)	713,276,047,662
Total spending (in Nairas)	Received from authorities (National Health Accounts 2010–16)	3,935,300,000,000
E	In health: {total spending} / GDP	3.84
W	Level of doctors' wages as % of GDP per capita that satisfies $E = 10w\frac{D + 0.5M}{100 - E^{oth}}$	5.88

Appendix III. Electric Power Generation, Transmission, and Distribution

We obtained power mix from the Nigeria's Federal Ministry of Power and the National Council on Power (NACOP).[51] The cost per kW of installed generation comes from international benchmarks. The average investment cost per kW of capacity is calculated as the weighted average of unit costs and share of installed capacity in the power mix.

The unit cost per kW is estimated at US$ 1,092. Table AIII.1 breaks down the calculations.

Table AIII.1. Unit Cost of Investment in On-Grid Electric Power Generation
(per kW)

Source		2016 MW	2016 Percent	2030 MW	2030 Percent	Investment cost per kW in US$
Conventional	Gas	3,121	71	13,000	41	760
	Coal	0	0	3,200	10	1,285
	Nuclear	0	0	2,000	6	2,000
	Sub-total conventional	3,121	71	18,200	57	
Renewable	Large Hydro Plants	1,200	27	4,700	15	2,000
	Small Hydro Power	45	1	1,200	4	1,285
	Solar PV	0	0	5,000	16	760
	Solar Thermal	0	0	1,000	3	650
	Wind Power	10	0	800	3	850
	Biomass	0	0	1,100	3	800
	Sub-total w LHP	1,255	29	13,800	43	
	Sub-total w/o LHP	55	1	9,100	28	
Total		**4,376**	**100**	**32,000**	**100**	**1,092**

Source: IMF staff calculations based on data from "Sustainable Energy for All Action Agenda (SE4ALL-AA)", approved by the National Council on Power.

Based on interviews with experts the costs in transmission and distribution costs are assumed to add 50 percent each to investment costs in capacity. We also assumed that investment costs in power storage will be offset by lower transmission and distribution costs. Therefore, the total costs of investment in electric power generation, transmission, and distribution were estimated at US$ 2,184 per kW.

[51] See: "Sustainable Energy for All Action Agenda (SE4ALL-AA)" (2016). National Council on Power, Federal Ministry of Power, Abuja, Nigeria.

Appendix IV. Roads

Unit Cost per Kilometer of Road

We estimated the share of future highways—national and state—local (district, urban, and project), and rural roads from Nigeria's Infrastructure Concession Regulatory Commission.[52] The cost per type of road is taken from World Bank and African Development Bank projects as well as engineering estimates (Table AIV.1).

Table AIV.1. Cost per km of Road
(in US$)

Type of road	Length (km)	Share (percent)	Cost per km (US$ thousands)	Source
Federal Roads (2-lane)	32,000	16.4	1,900	Estimated based on roads constructed under World Bank and AfDB projects
State Roads (2-lane)	31,000	15.9	1,000	Expert estimate only
Rural Roads (with low-cost surfacing)	132,000	67.7	117.5	Expert estimate only: US$110,000-125,000 per km
Total	**195,000**	**100.0**	**550**	**Estimated weighted cost per km**

Source: IMF staff calculations based on World Bank and African Development Bank projects, and engineering estimates.

We assumed that future roads are going to follow the same proportion. As a result, the average cost of road construction was estimated at US$550 thousand per kilometer.

Migration-Adjusted Rural Access Index

The Rural Access Index (RAI) is calculated based on a GIS model of the distribution of rural population, and a geospatial model of rural roads (including their location and type). Demographic dynamics affect the RAI even without additional roads. i.e., *ceteris paribus*, the migration from rural to urban areas increases mechanically the RAI. We account for demographic migration from rural to urban in 2030 areas to calculate the *migration-adjusted* RAI in 2030 keeping roads constant. The following equation presents the calculation:

$$RAI_{2030}^{migration-adjusted} = 1 - \underbrace{\frac{\overbrace{Rural_{2019} \times \left(1 - RAI_{2019}^{observed}\right)}^{current\ rural\ population\ not\ connected} - \overbrace{\left(Rural_{2019} - Rural_{2030}\right)}^{migration\ from\ rural\ to\ urban}}{Rural_{2030}}}_{migration-ajusted\ rural\ population\ witout\ access\ to\ roads}$$

where *Rural* is the share of rural population in 2019 and projected in 2030. Taking into account the projected migration from rural to urban areas (from 49.7 percent in 2018 to 40.8 percent in 2030 of the population living in rural areas), we adjusted the Rural Access Index from the

[52] See: https://www.icrc.gov.ng/135000km-road-network-nigeria-un-tarred-icrc/.

observed 25.5 percent in 2019 to a *ceteris paribus* migration-adjusted Rural Access Index of 31 percent.

Road Length Needed

Using a sample of low-income and emerging economies, we estimate the length of all-weather roads regressing road density on GDP per capita, population density, agriculture and manufacturing sector shares in the economy, urbanization rate, and migration-adjusted Rural Access Index—i.e., the share of the population that has access to road within two kilometers. This approach assumes away contemporaneous reverse causality: i.e., road density affects income per capita and population density with a substantial lag.[53] The regression specification is as follows:

$$lg\_cia\_density = lggdp\_cap\ rai\ agg\_gdp\ manu\_gdp\ lgpop\_density\ urban$$

where *lg_cia_density* is natural logarithm of road density, *lggdp_cap* is the natural logarithm of GDP per capita, *agg_gdp* is the aggregated GDP, *manu_gdp* is the ratio of manufacturing to GDP, *lgpop_density* is the natural logarithm of population density, and *urban* is the share of urban population in total population. The regression is restricted to low-income and developing economies, and emerging market economies with medium-range road density (i.e., it does not incorporate advanced economies, or countries with too low or too high road density).

We then use the point estimates from the regression to calculate the additional kilometers of road needed given Nigeria's projected population and GDP per capita growth and the increase in the RAI from 31 (migration-adjusted) to at least 75 percent by 2030.

We estimate the total cost of the additional road network by multiplying the estimated additional kilometers by the unit cost of constructing one kilometer, which is set at US$ 550,308 per kilometer.[54] To account for depreciation, we increase the total cost of the additional kilometers by 5 percent.

[53] Fay, M., and Yepes, T. (2003). *Investing in Infrastructure: What is Needed from 2000 to 2010?* The World Bank.

[54] See: Iommi, A., Ahmed, F., Anderson, E. C., Diehl, A. S., Maiyo, L., Peralta-Quirós, T., and Rao, K. S. (2016). *New rural access index: main determinants and correlation to poverty*. The World Bank.

Appendix V. Water and Sanitation

Definitions and Standards of Service

The goal in water and sanitation is full coverage in each category: end open defecation, and then access to basic water, sanitation, and hygiene, and finally safely managed water and sanitation provision. These categories are incremental: i.e., the safely managed implies access to basic water and sanitation. In this paper, we rely in the UN definition and threshold for each category:

1. **End of open defecation**: access to services that remove the need for open defecation—improved or unimproved toilet facility (e.g., pit latrines without a slab/platform, hanging latrines, bucket latrines)
2. **Basic water, sanitation, and hygiene**
   - 2.1. Basic water services: access to an *improved* water source within 30 minutes roundtrip
   - 2.2. Basic sanitation services: access to improved sanitation facility such as flush toilets or latrine with a slab
   - 2.3. Basic hygiene services: handwashing station in the household with soap and water present
3. **Safely managed water and sanitation**
   - 3.1. Safely managed water services: access to improved water source on the individual's premises
   - 3.2. Safely managed sanitation services: access to improved sanitation facility on household premises where excreta are safely disposed of in situ or treated off-site

Population Unserved

The percentage of served population in rural and urban areas, and the cost per capita of providing the service was obtained from different sources and revised data by government authorities during the mission. Table AV.1 reports the reviewed statistics of coverage by type of water and sanitation service.

The target population unserved in 2030 was extrapolated from the percentage of rural and urban population unserved in 2019 and the migration from rural to urban areas. This implies, *ceteris paribus*, an improvement in the coverage ratios by simple migration from unserved rural to served urban areas.

Total Number of Population Unserved and Cost of Water and Sanitation

The cost per type of service and population strata was computed as the product of the population underserved times the cost per capita of providing the service by type of service and population strata by times.

To avoid double counting and since the services are incremental (i.e., populations with safely managed sanitation have access to more basic services like water and latrines), we compute the total population unserved as the maximum of rural population unserved by type of service plus the maximum of urban population unserved by type of service. Following the WASH methodology developed by the World Bank,[55] the total cost was calculated as the full cost of providing safely managed water and sanitation services plus half of the cost of providing the basic water and sanitation.

Table AV.1. Statistics of Coverage by Type of Water and Sanitation Service

	Rural		Urban		
	Coverage (percent)	Cost per capita (US$)	Coverage (percent)	Cost per capita (US$)	Source
End open defecation (100 = no open def.)	70	15.3	89	15.3	2018 WASH NORM.
Basi water	60	78.9	87	78.9	2018 WASH NORM
Basic sanitation	38	89.9	50	89.9	2018 WASH NORM
Basic hygine	18	18.75	27	18.75	2018 WASH NORM
Safely managed water	3	156.0	4.9	468.1	2016/2017 MICS Report
Safely managed sanitation	17.2	59.5	24	178.5	2016/2017 MICS Report

Source: IMF staff calculations.
Note: Average costs were provided by the Federal Ministry of Water Resources in NGN and converted to US$ at the rate of 360 NGN = 1 USD. Rural and urban cost per capita are assumed to be similar for basic services, and urban cost per capita are assumed to be three times larger than in rural areas for safely-managed services.

[55] Hutton, G., and Varughese, M., 2016, "The Costs of Meeting the 2030 Sustainable Development Goal Targets on Drinking Water, Sanitation, and Hygiene." Water and Sanitation Program Technical Paper, World Bank.

Appendix VI. Annual Cost as a Constant Share of GDP[56]

Let K^*_{2030} be the additional stock of infrastructure required by 2030 to meet the desired goals. We can write the capital stock at any point in time as:

$$K_t = K_{t-1}(1-d) + I_t$$

where *d* is the annual depreciation rate and I_t is the gross investment in year *t*. Therefore, the additional stock built between 2018 and 2030 will be equal to:

$$K_{2018-2030} = \sum_{t=2018}^{T=2030} I_t(1-d)^{T-t}$$

which equals the additional stock required by 2030 to meet the desired goals. Standardizing time relative to 2018, we can write this as:

$$K^*_{2030} = \sum_{t=0}^{T=12} I_t(1-d)^{T-t}$$

If we want spending on roads to be a constant fraction of GDP between 2018 and 2030 then spending must grow at the rate as GDP. Thus, we can write spending in each year as:

$$I_t = I_0(1+g)^t$$

where I_0 is the initial (in 2018) annual spending and g is the annual constant growth rate of GDP between 2018 and 2030. Thus, we can write the additional stock of roads required by 2030 as:

$$K^*_{2030} = \sum_{t=0}^{T=12} I_0(1+g)^t(1-d)^{T-t} = I_0 \sum_{t=0}^{T=12} (1+g)^t \frac{(1-d)^T}{(1-d)^t}$$

$$K^*_{2030} = I_0(1-d)^T \sum_{t=0}^{T=12} \left(\frac{1+g}{1-d}\right)^t$$

The summation term is a geometric series, so the whole expression becomes:

$$K^*_{2030} = I_0(1-d)^T \frac{1-a^{T+1}}{1-a}$$

where $a = (1+g)/(1-d)$. From this we can solve for the initial spending, as all other terms are known:

$$I_0 = \frac{K^*_{2030}}{(1-d)^{12}\frac{1-a^{13}}{1-a}}$$

Finally, we scale I_0 to GDP in 2018 to get the spending in terms of percent of GDP. This ratio remains constant between 2018 and 2030 and generates the additional stock required by 2030 to meet the desired goals.

[56] Formula developed by Fernanda Brollo from the IMF's Fiscal Affairs Department.