COMPENDIUM OF CLEAN AIR ACTION IN AFRICA

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Introduction

As the Global South battles toxic air pollution and the effects of climate change, there is considerable interest in understanding how countries in Africa are preparing to take on these challenges. What is the direction and scale of change? What can countries in Africa learn from each other and other countries in the Global South that share common challenges but also have unique imperatives and are shaping their respective solutions for clean air accordingly?

This curiosity has also been the rallying point for the Pan Africa Network on Clean Air Solutions initiated by the Centre for Science and Environment (CSE) to bring together key regulators and stakeholders from different countries of Africa for knowledge sharing and cross learning.

This network has evolved and gathered momentum through a series of meetings held since 2015 at the Pan-Africa level to debate and exchange ideas on emerging issues, initiatives and solutions. A large number of countries have participated in the network discussion—including Nigeria, Ethiopia, Kenya, Uganda, Zambia, Mauritius, Zimbabwe, South Sudan, Tanzania, Zanzibar, Senegal, Cote d'Ivoire, Ghana, Egypt, Mozambique, Malawi and Rwanda.

This network participation and discussion has brought out the richness of the efforts being made and captured the direction of change across several countries in Arica. This has also helped to highlight the unique challenges and imperatives of each country.

In the Pan-Africa network meeting that was held in November 2020, it was decided that as this conversation evolves it may be helpful to document emerging good practices along with network participants to prepare a compendium of clean air action to reflect the real action on ground. This is expected to show what has been possible so far.

Therefore, this rapid documentation has been carried out based on the latest information available on the emerging good practices in the region. We have put together information that could be gathered through the Pan-Africa network and workshops, regional consultations, training workshops and country-level stakeholder workshops, meetings, and the available literature from the leading organizations in the region.

This is a base document that is expected to evolve to reflect newer changes. This includes the latest information on air quality trends and public health challenges in the region, initiatives on air quality monitoring and management, efforts to improve vehicle technology and fuel quality, alternative fuel programmes, initiatives to regulate used vehicle imports, and on-road emissions management and electric vehicles programme. This has also tracked mobility initiatives that include efforts to improve formal and informal public transport, walking and cycling, and vehicle restraint measures. This will be further enriched as more sectors including industry, waste management and construction are also added in the next stage.

Information available is not equally in-depth for all practices. But this is a dynamic process that will keep getting updated with emerging solutions, implementation and outcomes as knowledge sharing in the network is enhanced. This is also a mix of older and newer practices. While some case studies could be assessed at the ground level, several others could not be so assessed due to pandemic restrictions. Nonetheless, this compendium showcases what has been done to build optimism for the future.

This overview makes it clear that several multi-sector solutions are unfolding quite rapidly across African cities. The scale is still limited but the change is certain.

Air quality regulators are increasingly developing capacity for monitoring air quality, forecasting and dissemination of air quality data, and source assessment to prepare their respective clean air action plans.

To move action on vehicle technology and fuel quality, inter-governmental and regional coordination has provided support to in-country action. The harmonized introduction of 50 ppm sulphur fuel in east Africa is an evidence of this. Moreover, regional consensus is emerging gradually on various strategies to control import of old vehicles.

Several initiatives in the transportation sector reflect adoption of new generation of sustainable policy principles that have helped several cities leapfrog to more advanced design solutions for mobility management. Cities are leapfrogging to well-designed bus rapid transit systems, integration of formal and informal transport, pedestrian and cycling facilities, and celebration of car free days.

While there still remain many challenges, these positive signs are evidence of what is possible in the Global South. There are opportunities available in the early stages of growth which need to be leveraged to inform and support policy making, and implementation and shaping of fiscal strategies to enable the leapfrog strategies for clean air. The network will continue to track changes to support action. Some things that need to be done are:

- Build good data on air quality, exposures and health impact, and create emissions profile using data science to support air quality management and implementation of multi-sector clean air action plans.
- Adopt legal framework for air quality management and compliance to meet time-bound clean air targets.
- Need coordinated and harmonized regional action and strong in-country strategies and roadmaps to accelerate clean vehicle technology and fuel quality, on-road emissions management, and curbs on import of old vehicles.
- Develop industrial and fiscal strategies to accelerate electrification of targeted vehicle segments.
- Adopt and implement comprehensive transportation and mobility plans for scaling up of integrated public transport options and walking and cycling infrastructure.
- Design and implement demand management measures including parking policy, pedestrianization and low emissions zones in the early stages of motorization.
- Implement financing and funding strategies to support implementation and meet the cost of transition.
- Build knowledge, capacity, skills and awareness to support implementation of ambitious action plans to mitigate air pollution and climate change.

Chapter 1: Air quality and public health challenges

What are the dimensions of growing air quality and public health risks in Africa?

Air quality monitoring is extremely limited in Africa and that makes air quality trend analysis challenging. Limited data allows only a fragmented picture of the status of air quality in most cities.

The most recent analysis of air quality and public health risk is available from the State of Global Air (SoGA) 2020. This consolidated data set and analysis provides insight into the emerging trend in Africa. Here is a highlight of the challenges based on the SoGA report.

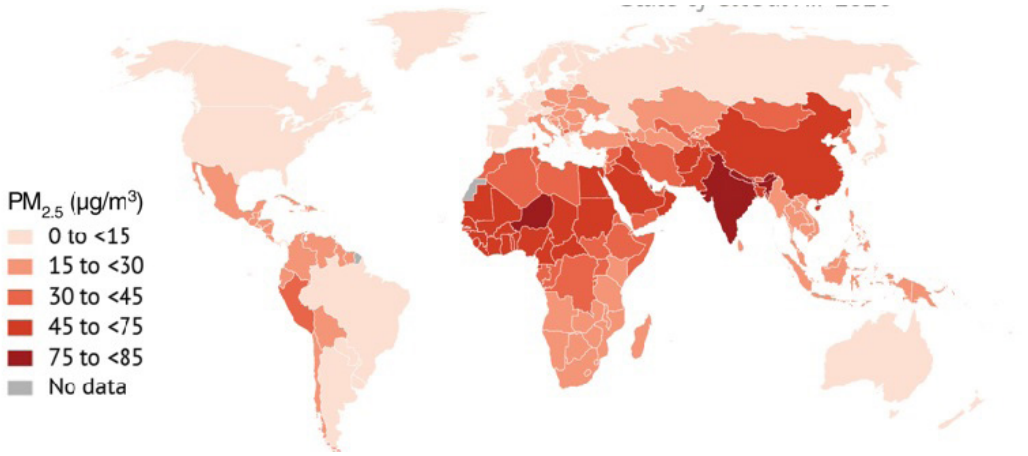
High $PM_{2.5}$ concentrations: Africa is in the grip of high particulate pollution with tinier fraction $PM_{2.5}$ emerging as a serious concern (see *Map 1: Population-weighted annual average $PM_{2.5}$ concentrations*)**.** The annual average trend in population-weighted $PM_{2.5}$ concentrations brings out this challenge. Higher daily exceedances could pose a bigger challenge, especially in cities and areas around major pollution sources.[1]

Sub-Saharan Africa and North Africa show highest population-weighted annual average $PM_{2.5}$ concentrations. They are above the global average and far above the WHO guidelines (see *Graph 1: $PM_{2.5}$ population-weighted annual average concentrations in Sub-Saharan Africa and North Africa*).

Globally, some populous countries have reported decline in annual average $PM_{2.5}$ exposures. These also include countries of Africa. While Egypt has reported a substantial decline of 10.6 $\mu g/m^3$ from 78.5 to 67.9 $\mu g/m^3$, Democratic Republic of the Congo and Ethiopia also reported marginal declines of 0.02 $\mu g/m^3$ and 0.24 $\mu g/m^3$ respectively. However, Nigeria reported a 7.5 $\mu g/m^3$ $PM_{2.5}$ increase from 62.9 to 70.4 $\mu g/m^3$ (see *Graph 2: Substantial $PM_{2.5}$ decline in Egypt and increase in Nigeria amongst 20 populous countries*).

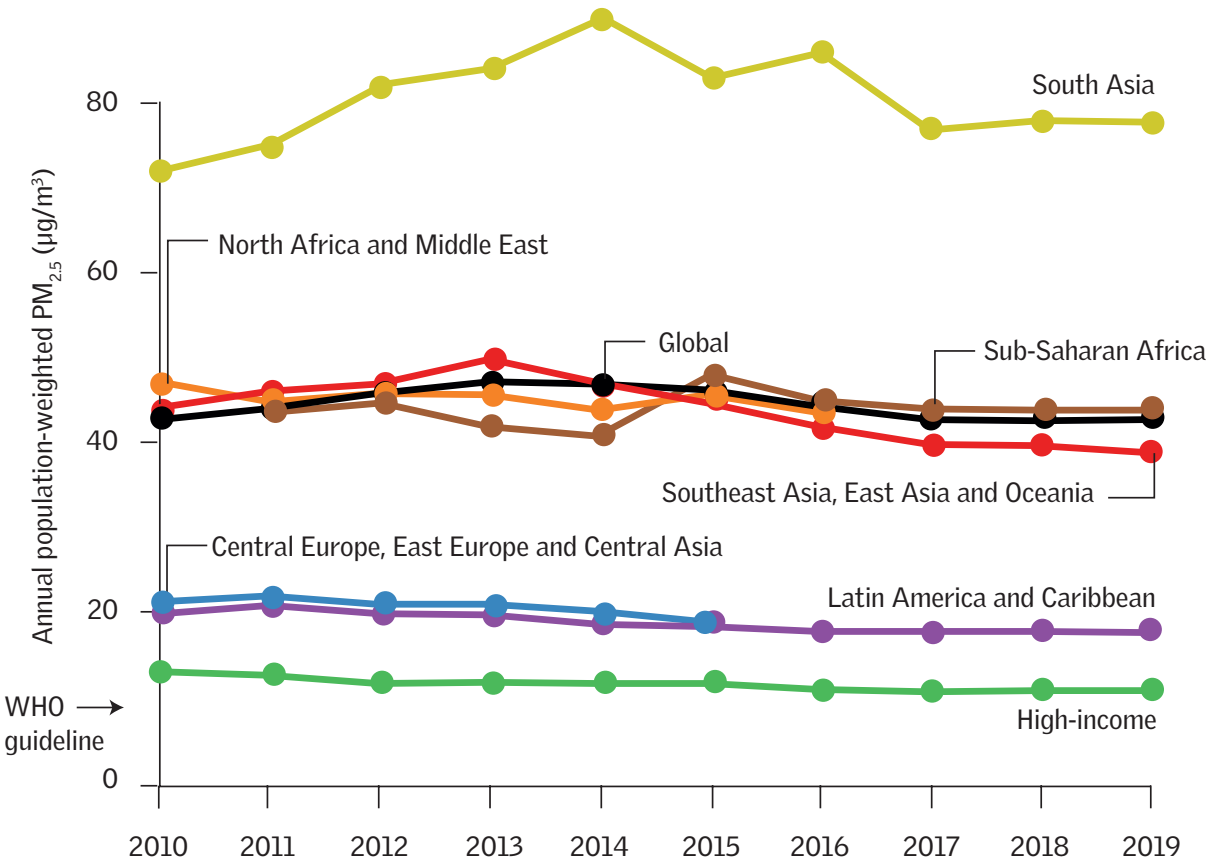
$PM_{2.5}$ exposure in Africa: It is important to note that five African countries—Niger, Nigeria, Egypt, Mauritania and Cameroon—are amongst the top ten countries globally with highest $PM_{2.5}$ exposure (population-weighted $PM_{2.5}$

Map 1: Population weighted annual average $PM_{2.5}$ concentrations



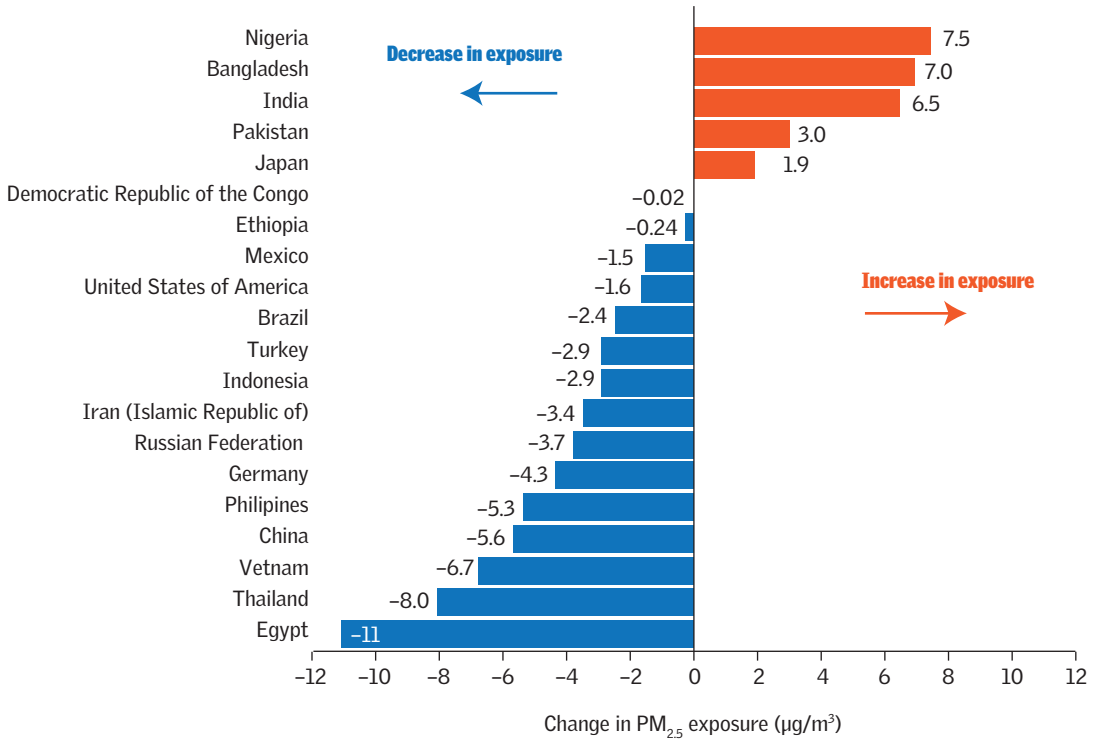
Source: SoGA 2020 Report, p.6

Graph 1: $PM_{2.5}$ population-weighted annual average concentrations in Sub-Saharan Africa and North Africa



Source: SoGA 2020 Report, p.7

Graph 2: Substantial $PM_{2.5}$ decline in Egypt and increase in Nigeria amongst 20 populous countries



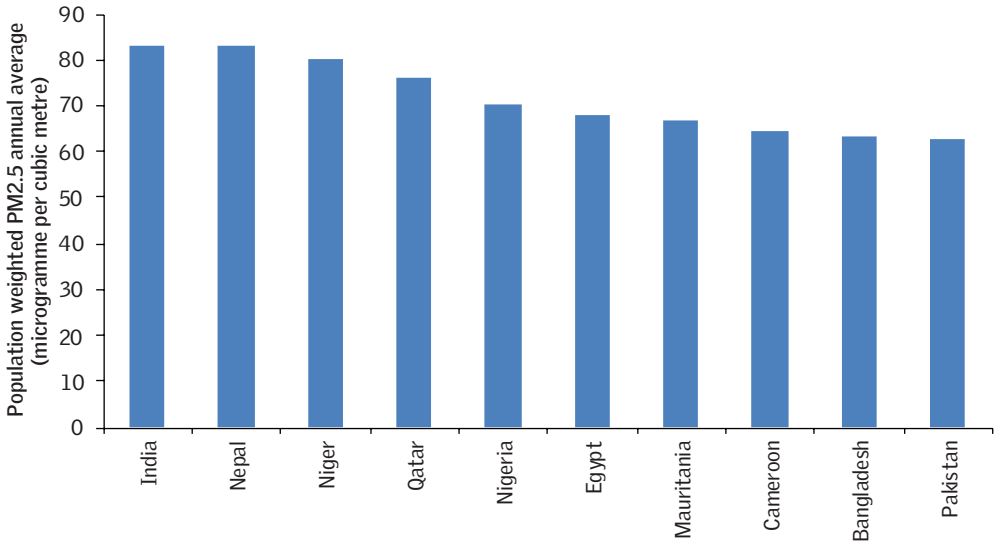
Source: SoGA 2020 Report, p 7.

annual averages). The $PM_{2.5}$ annual averages in these five countries range from 64.5–80.1 µg/m^3 (see *Graph 3: Top 10 countries with highest populated-weighted $PM_{2.5}$ annual averages*).

While Mauritius has the lowest concentration, Niger has reported the highest. The top ten polluted countries in the African region—Niger, Nigeria, Egypt, Mauritania, Cameroon, Mali, Senegal, Chad, Gambia and Cote d'Ivoire—had $PM_{2.5}$ concentrations in the range of 55.6–80.1 µg/m^3 (see *Graph 4: Population-weighted $PM_{2.5}$ annual average in the Africa region*).

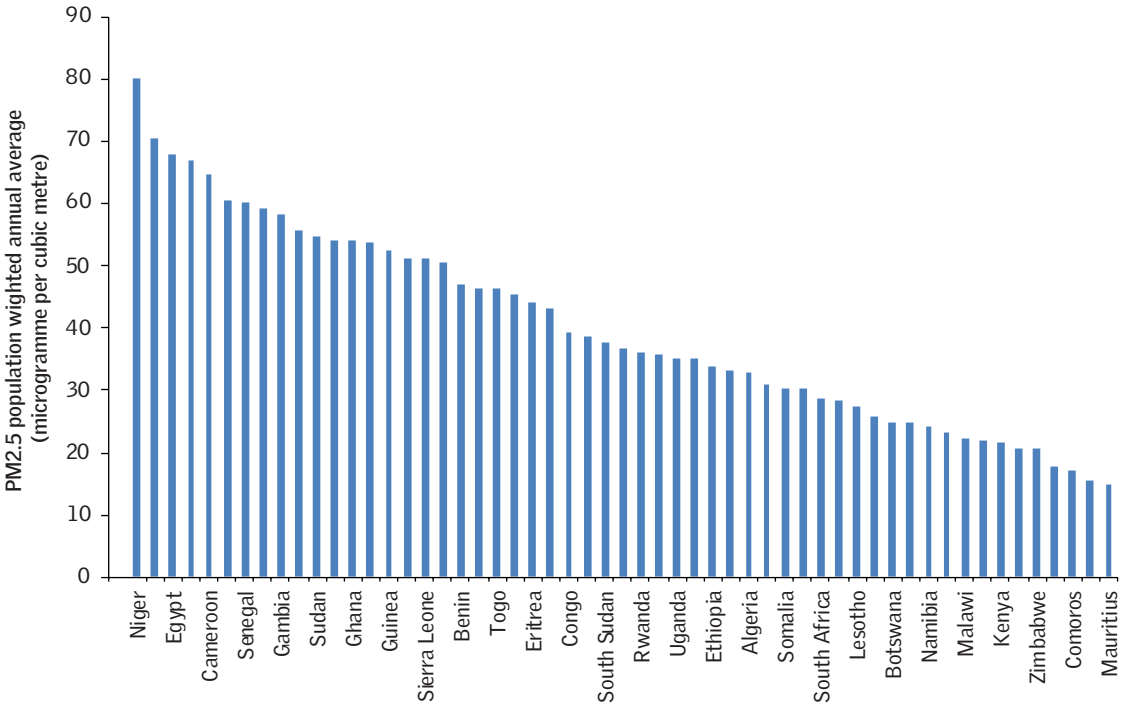
Ozone concentration: Even before Africa could address particulate pollution, it has started experiencing a slow rise in ozone pollution, a deadly toxic gas (see *Map 2: Population-weighted average seasonal 8-hour daily maximum ozone concentration*). However, the top 10 countries with the highest average ozone exposures are in Asia and Middle East. Although, North Africa is in the danger zone (see *Graph 5: Region-wise ozone concentration*).

Graph 3: Top 10 countries with highest populated-weighted $PM_{2.5}$ annual averages



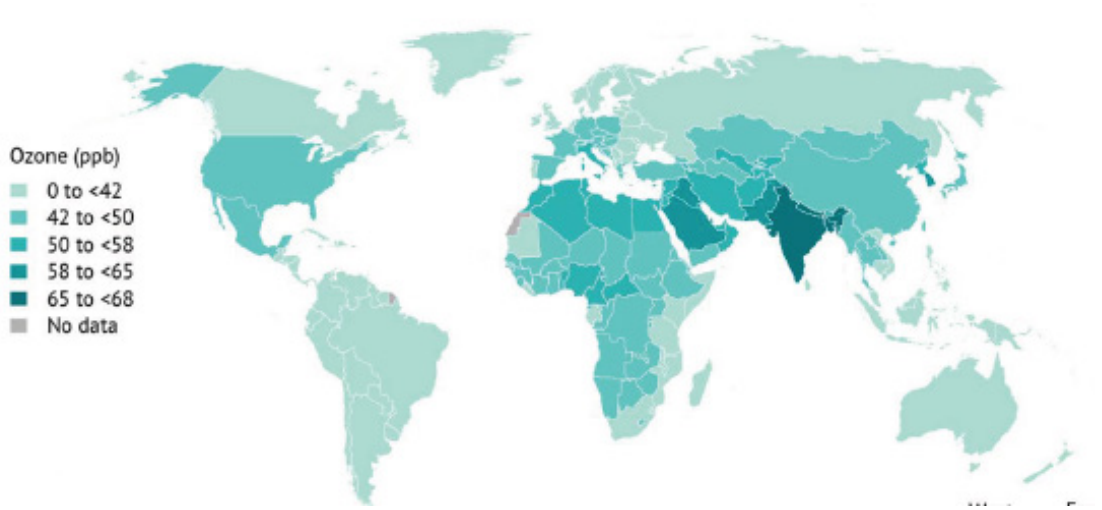
Source: CSE based on SoGA 2020 report

Graph 4: Population weighted $PM_{2.5}$ annual average in the Africa region



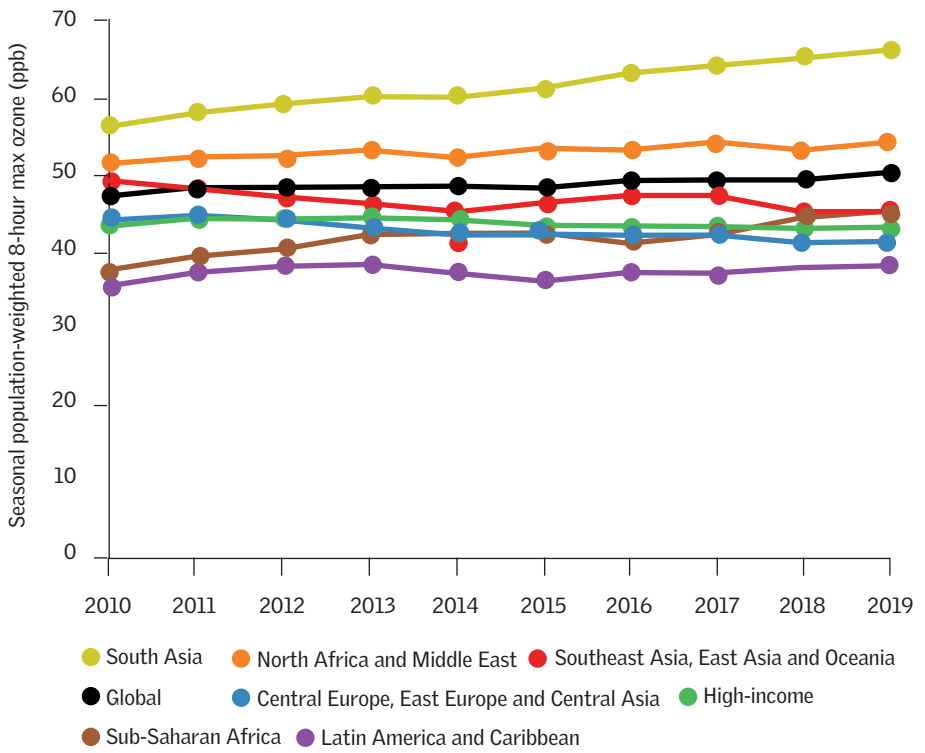
Source: CSE based on SoGA 2020 report

Map 2: Population weighted average seasonal 8-hour daily maximum ozone concentration



Source: SoGA 2020 Report, p 10

Graph 5: Region-wise ozone concentration



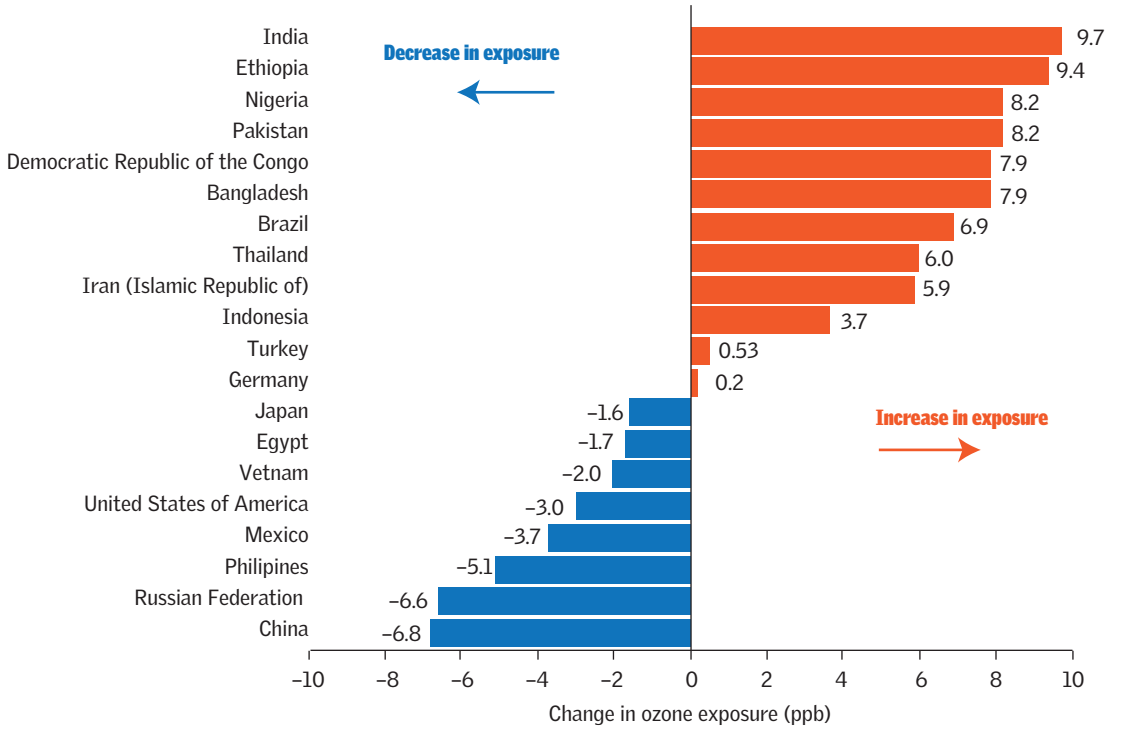
Source: SoGA 2020 Report, p 10.

During 2010 and 2019, increases in ozone concentration were reported in three of the 20 most populous countries in Africa—Ethiopia, Nigeria, and the Democratic Republic of the Congo. Ethiopia showed a steep increase of 27 per cent from 24.9 ppb in 2010 to 44.3 ppb in 2019. However, Egypt is amongst the 8 countries showing 1.7 ppb ozone levels reduction (see *Graph 6: Ozone increase in three African countries and reduction in one amongst the 20 most populous countries*).

Ozone exposure in Africa: Ozone concentrations range from 19.4 to 54.3 ppb in Mauritius and Algeria respectively. The top ten countries with highest ozone exposure are Algeria, Libya, Central African Republic, Tunisia, Nigeria, Egypt, Benin, Togo, Morocco and Cameroon (see *Graph 7: Population weighted 8-hourly seasonal average ozone*).

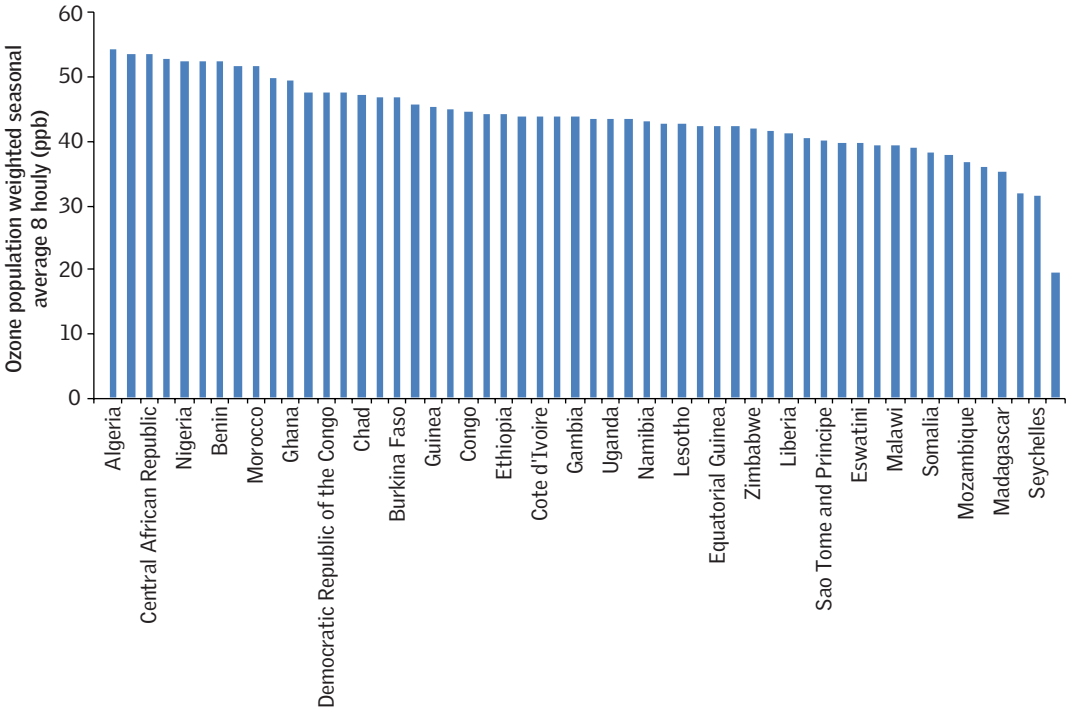
Household air pollution (**HAP**)**:** While ambient air quality outdoor has already turned toxic, household pollution due to burning of solid fuels for cooking and lighting has continued to remain a cause of very high exposure and ill health in

Graph 6: Ozone increase in three African countries and reduction in one amongst the 20 most populous countries



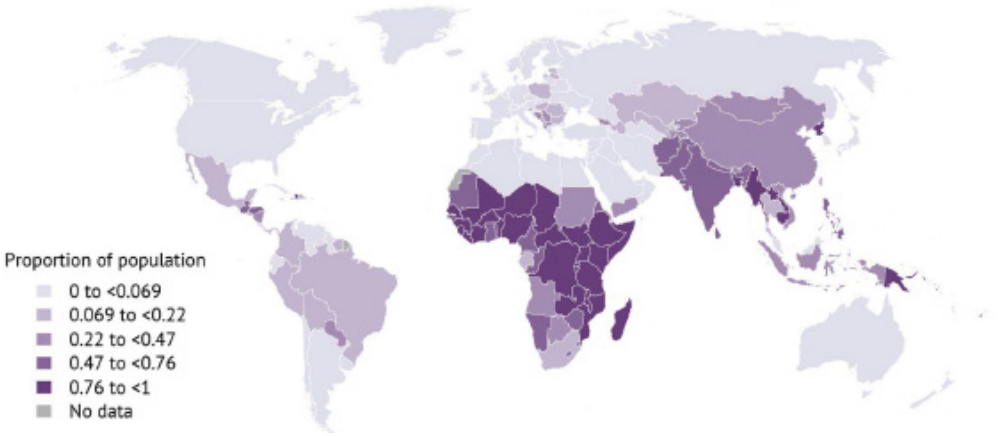
Source: SoGA 2020 Report, p 11.

Graph 7: Population weighted 8-hourly seasonal average ozone



Source: CSE based on data from SoGA 2020 report

Map 3: Widespread HAP exposure in Sub-Saharan Africa



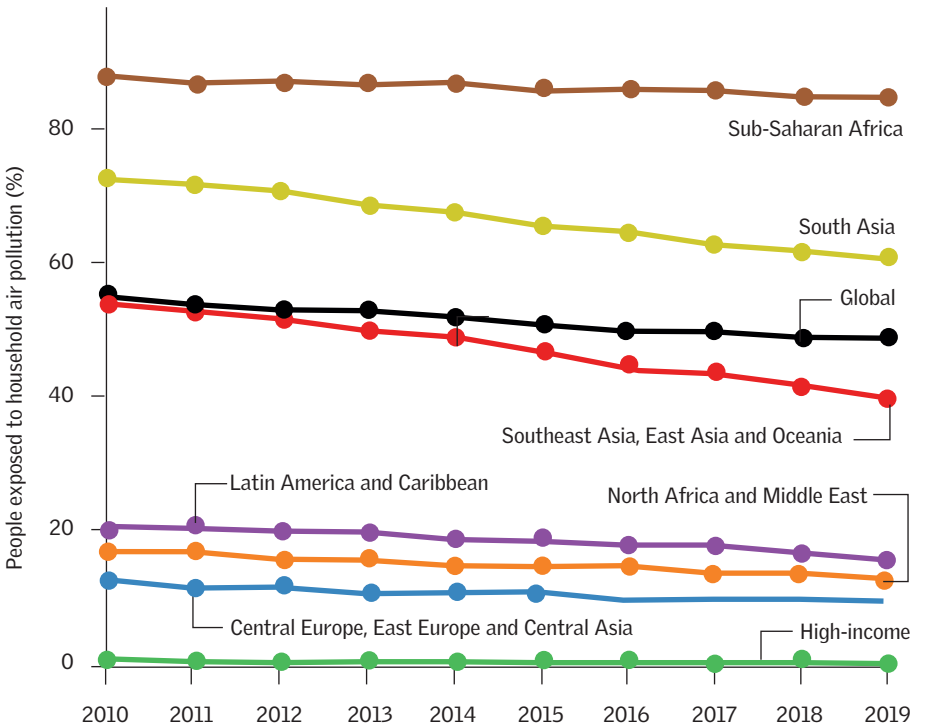
Source: SoGA 2020 Report, p.12.

Africa. Use of firewood, biomass, kerosene, coal, charcoal, etc. to cook food and for heating and other purposes has increased indoor or household air pollution. Access to clean fuel needs to be explored and expedited to lower the household air pollution burden. Sub-Saharan Africa and parts of Asia show widespread household air pollution exposure (see *Map 3: Widespread HAP exposure in Sub-Saharan Africa*).

The SoGA 2020 report points out the slow progress that has been made in Sub-Saharan Africa with regard to HAP (see *Graph 8: Population exposed to HAP during 2010–19*). However, with adoption of cleaner fuels globally, HAP exposures and health impacts are declining. Since 2010, in South Asia, Southeast Asia, East Asia, and Oceania Super Regions, use of solid fuels has reduced slowly and steadily. But that still leaves 49 per cent of the world's population—about 3.8 billion people—exposed to HAP from the burning of solid fuels. Most of them live in just 17 countries—which have over 50 million people and more than 10 per cent of the population relying on solid fuels for cooking.[2] Six of these 17 countries are in Africa. These are Nigeria, Ethiopia, Democratic Republic of the Congo, Tanzania, Kenya and South Africa.

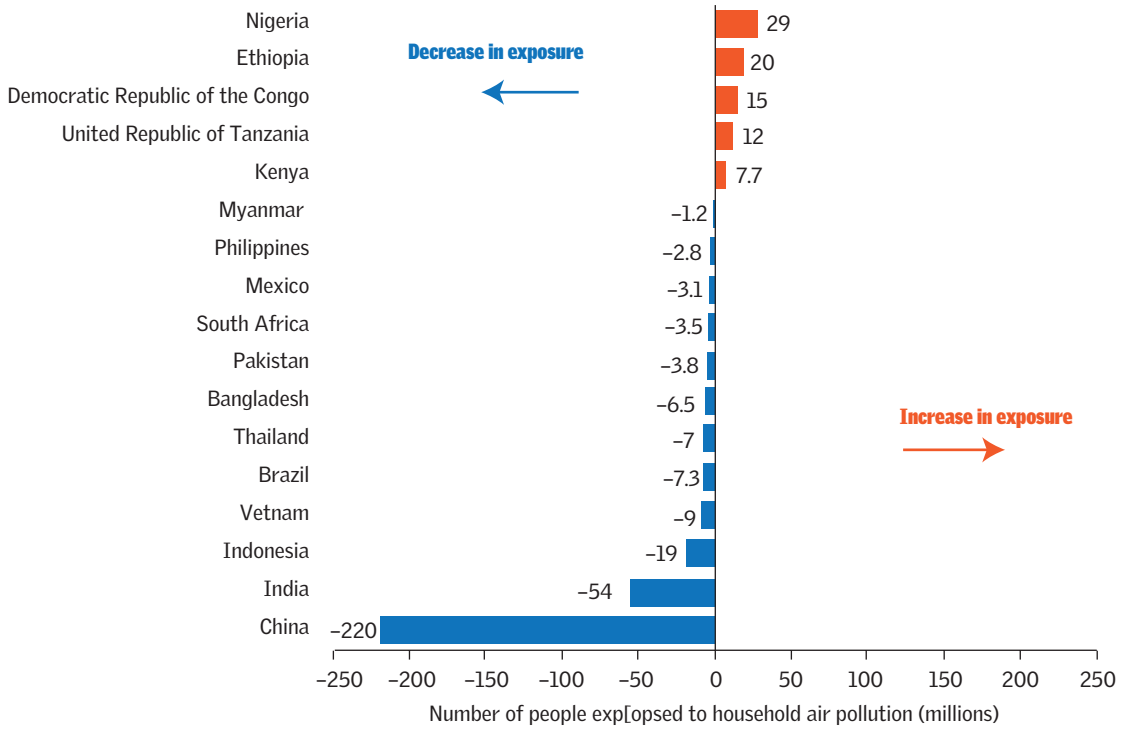
HAP exposure in Africa: The SoGA 2020 report notes, 'Several countries in Africa with fast-growing population actually experienced net increase in the numbers of people exposed to household air pollution, despite reductions in the percentages of their populations using solid fuels for cooking. Nigeria, for example, reduced

Graph 8: Population exposed to HAP during 2010–19



Source: SoGA 2020 Report, p.12

Graph 9: Increased HAP exposure in 5 African countries and decline in 1

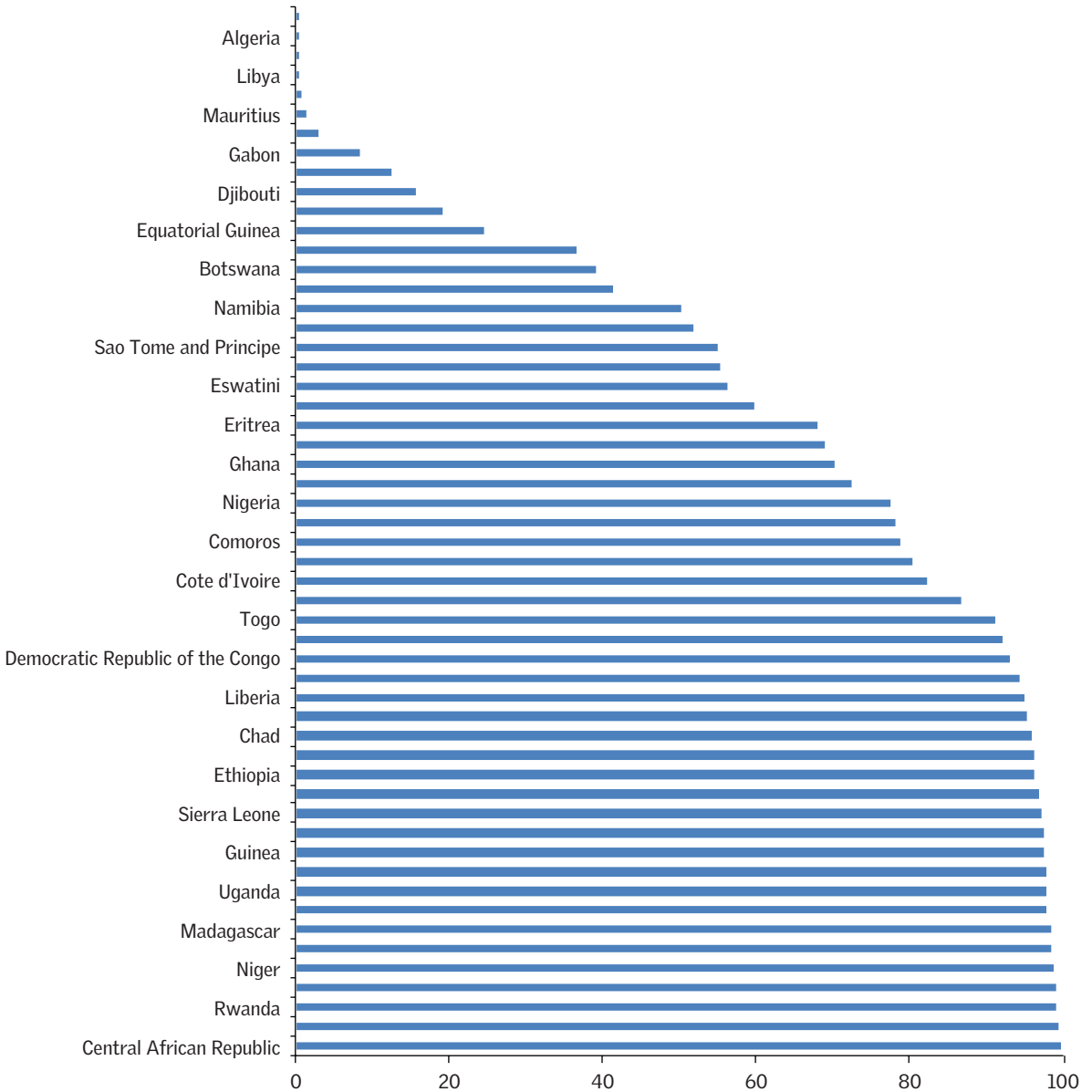


Source: SoGA 2020 Report, p 13.

the percentage of its population using solid fuels from 82 per cent to 77 per cent, but population growth meant that 29 million people have remained exposed. Increase in the numbers of people exposed occurred in countries such as Ethiopia and the Democratic Republic of the Congo where 96 per cent and 93 per cent of the population, respectively, continue to rely on solid fuels for cooking.'[3] However, South Africa has reported a decline (see *Graph 9: Increased HAP exposure in 5 African countries and decline in 1*).

The top ten African countries with the highest proportion of households cooking with solid fuels are Central African Republic, South Sudan, Rwanda, Burundi, Niger, Mali, Madagascar, Tanzania, Uganda, and Guinea-Bissau. More than 97 per cent of the population in these countries is estimated to be using solid fuels for cooking[4] (see *Graph 10: Household air pollution exposure due to solid fuel burning for cooking in Africa*).

Graph 10: Household air pollution exposure due to solid fuel burning for cooking in Africa



Source: CSE based on SoGA 2020 report

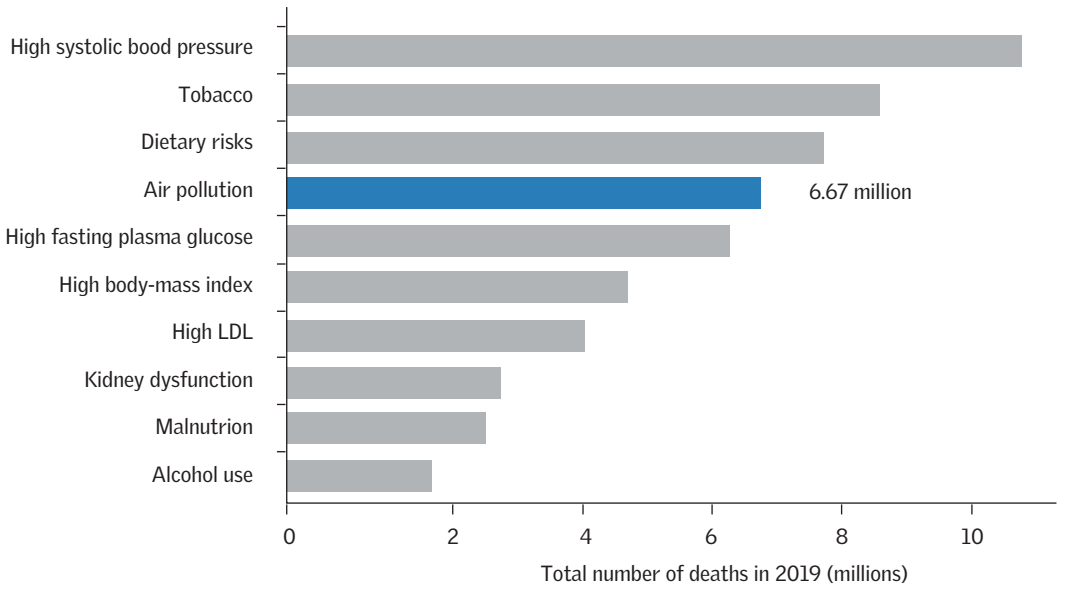
Chapter 2: Disease burden in Africa

How is air pollution related disease burden increasing across Africa?

Air pollution was the fourth leading risk factor for deaths in 2019 after high blood pressure, tobacco use and dietary risks. Globally, it is estimated to have caused 6.67 million deaths worldwide, which is nearly 12 per cent of all deaths (see *Graph 11: Air pollution is the fourth leading risk factor for deaths*). Of these, 7 per cent were attributable to ambient $PM_{2.5}$ pollution, 4 per cent to HAP and 1 per cent to ambient ozone pollution (see *Graph 12: Risk factors for global deaths*). Air pollution is also the leading environmental risk factor. It is also said to have caused more deaths than traffic collisions worldwide, which are estimated at 1.28 million.

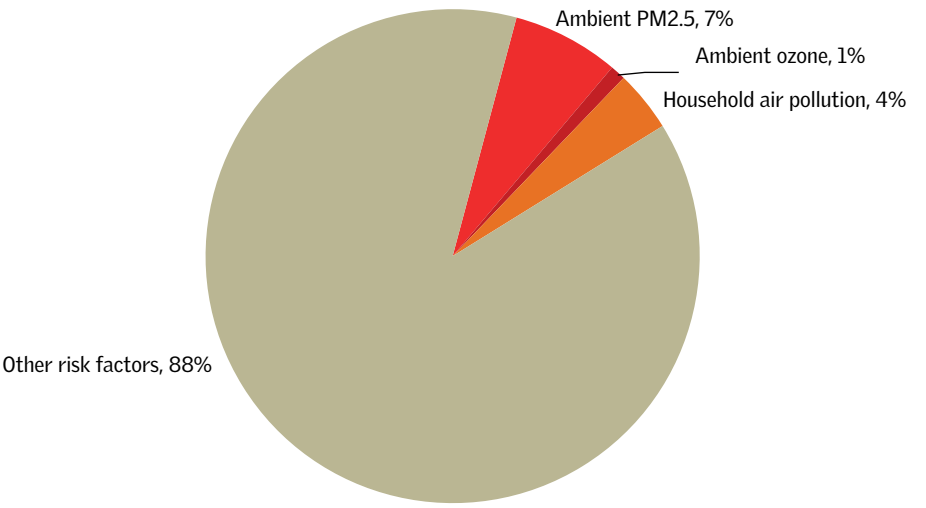
Non-communicable diseases (NCDs): NCDs cause the highest (about 80 per cent) air pollution burden (see *Graph 13: Global deaths attributable to total air pollution from specific causes*). $PM_{2.5}$, HAP and ozone together contribute to 40 per cent of COPD deaths. Nearly 30 per cent of lower-respiratory infection and 20 per cent of infant mortality in the first month of life is also caused by air pollution. Air pollution

Graph 11: Air pollution is the fourth leading risk factor for deaths



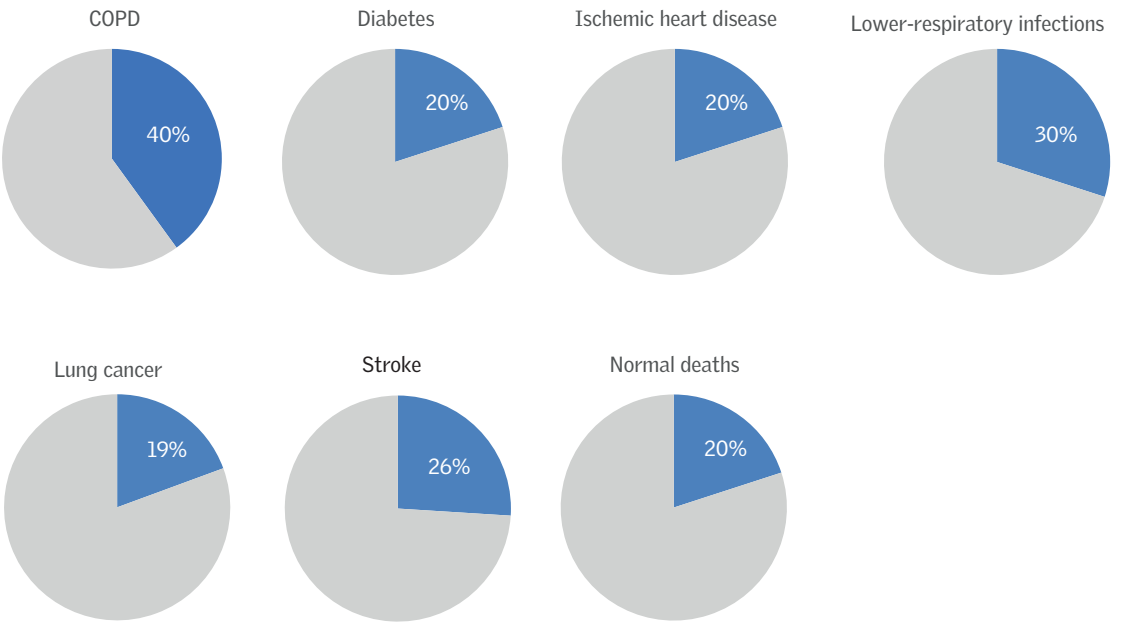
Source: SoGA 2020 Report, p.3

Graph 12: Risk factors for global deaths



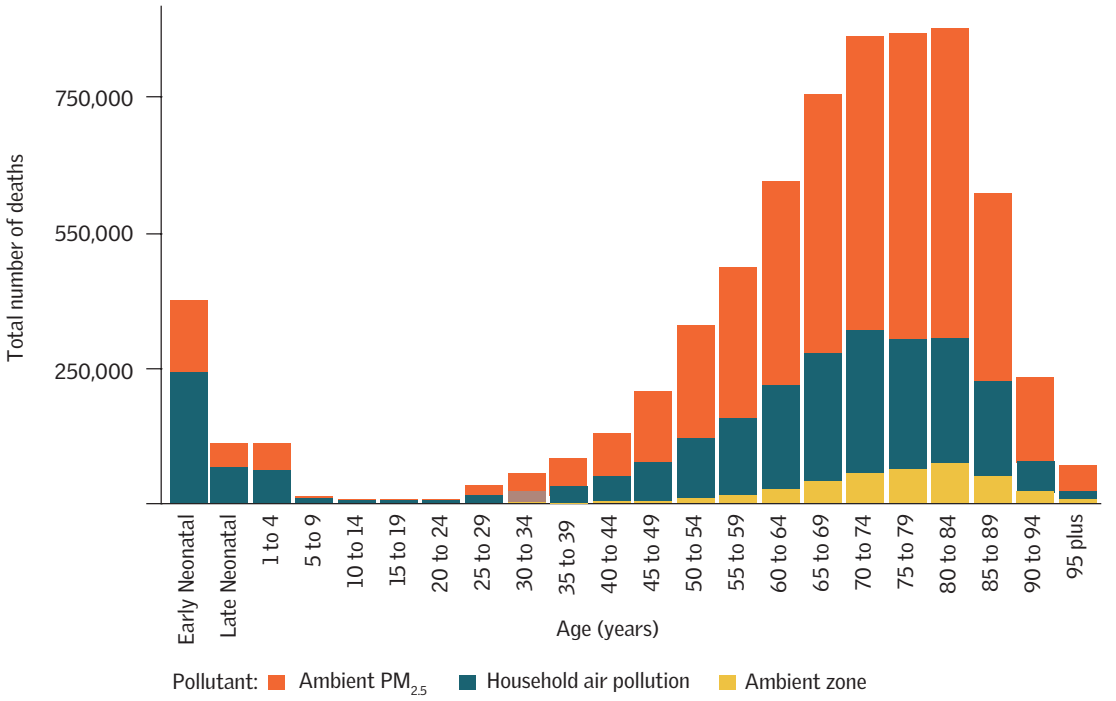
Source: SoGA 2020 Report, p.15

Graph 13: Global deaths attributable to total air pollution from specific causes



Source: SoGA 2020 Report, p.15

Graph 14: Children and elderly are the most impacted



Source: SoGA 2020 Report, p.16

impacts children and elderly the most (see *Graph 14: Children and elderly are the most impacted by air pollution*). While ambient $PM_{2.5}$ and HAP cause highest deaths and disability-adjusted life years (DALYs) across all age groups, COPD impact of ozone is seen in adults due to years in disease development.

Air pollution deaths in Africa: There is huge variability in air pollution related deaths in Africa. It ranges from 36 deaths, the lowest in Seychelles, to 0.197 million deaths in Nigeria, the highest. The top 10 countries include Nigeria, Egypt, Ethiopia, Democratic Republic of the Congo, Tanzania, South Africa, Niger, Morocco, Somalia and Kenya (see *Graph 15: Air pollution deaths in Africa*). Asian and African countries report the highest $PM_{2.5}$ age-standardized death rates and DALYs. These include Egypt (157 deaths/100,000 population), India (96/100,000), China (81/100,000), Iran (63/100,000) and Nigeria (59/100,000).

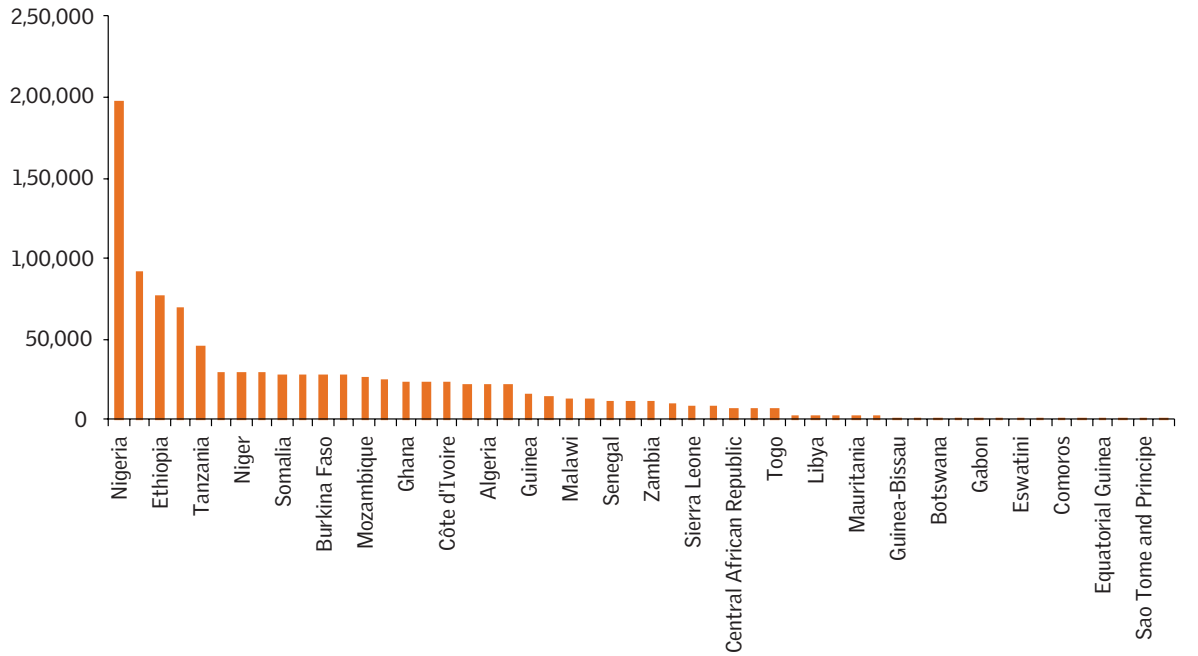
Total mortality is also high in many of the same countries where age-standardized death rates are high. In North Africa and the Middle East, the 10 countries with the

highest numbers of $PM_{2.5}$-attributable deaths include Egypt, which had 91,000 such deaths. In Sub-Saharan Africa, the top 10 countries with the highest burden are Nigeria (68,500 deaths), South Africa, Ghana, Democratic Republic of the Congo, Cameroon, Ethiopia, Côte d'Ivoire, Tanzania, Angola and Kenya.[5]

Ozone deaths: In 2019, long-term exposures to ozone contributed to an estimated 365,000 deaths from COPD worldwide, accounting for 11.1 per cent of all COPD deaths globally. This premature loss of life equates to 6.21 million DALYs from COPD across the world. It is important to note that African countries are not amongst the top 10 with highest ozone pollution deaths (see *Graph 16: Top 10 countries with highest deaths from ozone pollution*).

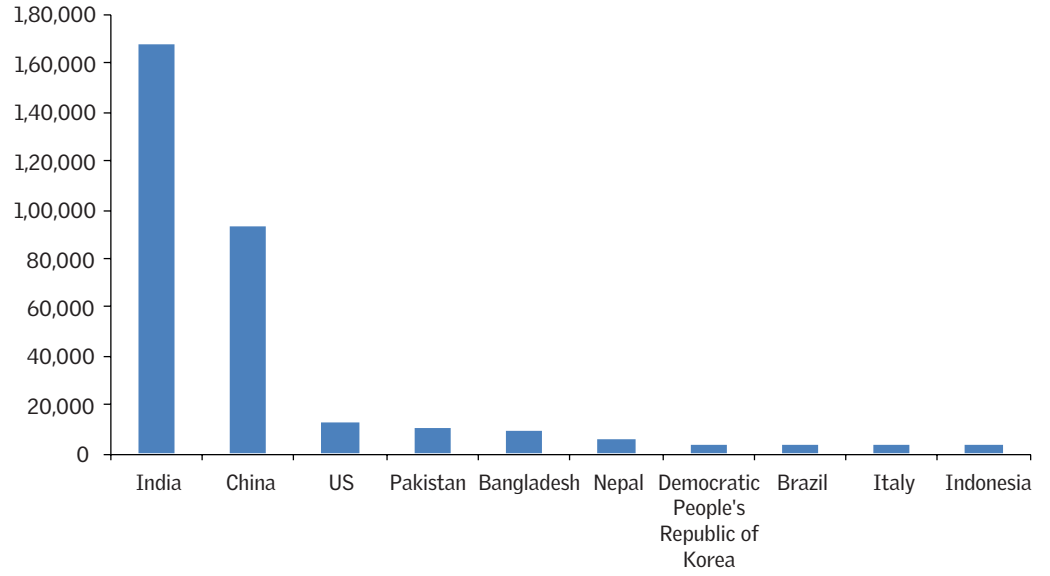
Changes in ozone-attributable deaths among the world's 20 most populous countries showed that 15 of these countries experienced increases in ozone pollution burden. The largest proportional increases were observed in Brazil (191 per cent), Ethiopia (171 per cent), Democratic Republic of the Congo (97 per cent), and Indonesia (89 per cent) (see *Graph 17: Ozone deaths in 20 most populous countries*). Congo and Nigeria are in the top 20 global list.

Graph 15: Air pollution deaths in Africa



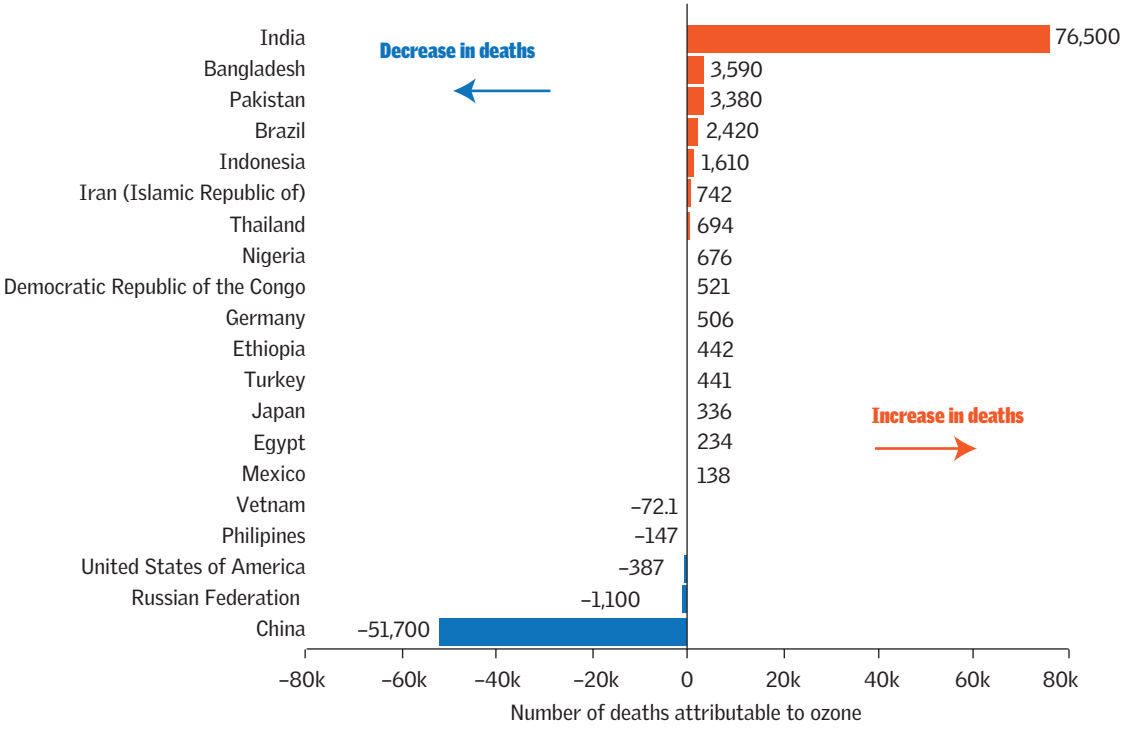
Source: CSE, based on SOGA 2020 report

Graph 16: Top 10 countries with highest deaths from ozone pollution



Source: CSE, based on SOGA 2020 report

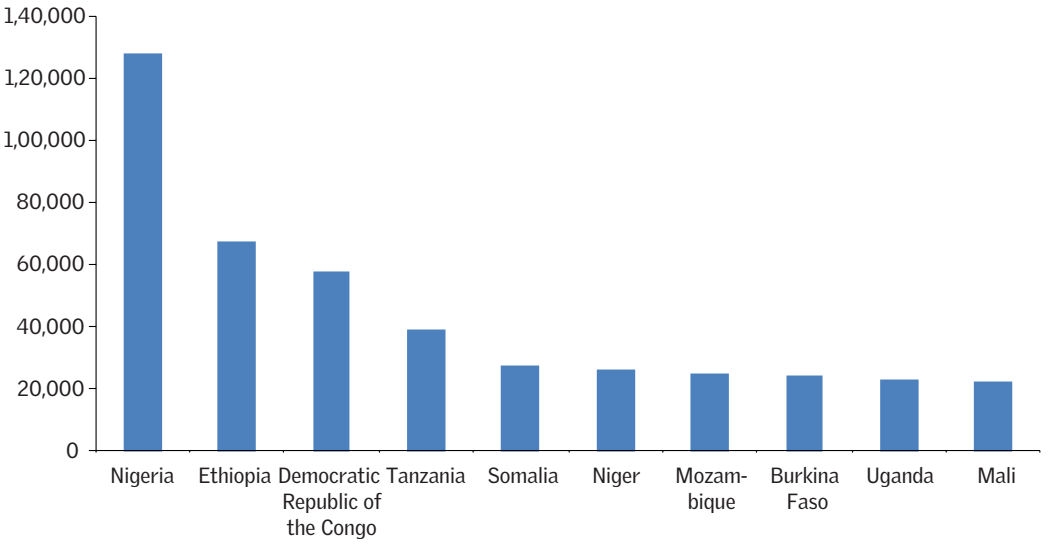
Graph 17: Ozone deaths in 20 most populous countries



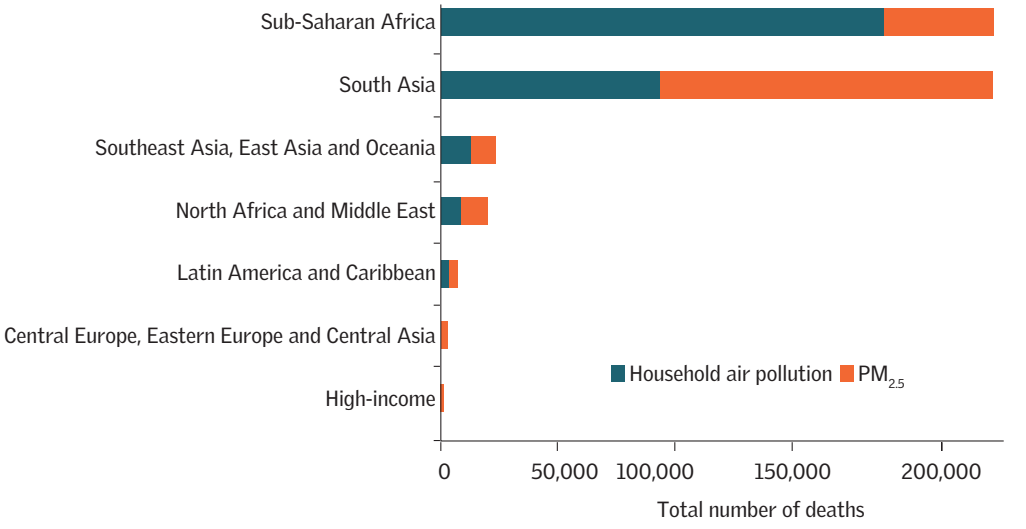
Household air pollution

Neonatal mortality: In 2019, air pollution contributed to 476,000 deaths globally among infants in their first month of life (75 per cent related to low birth weight and preterm birth). Nearly 20 per cent of new-born deaths were attributed to air pollution. In Africa, Democratic Republic of the Congo reported 52 per cent infant deaths, Ethiopia 23 per cent and Uganda 21 per cent. Two-thirds of all infant deaths are attributable to HAP. Sub-Saharan Africa bears the maximum burden (see *Graph 19: Household air pollution impacting infants*).

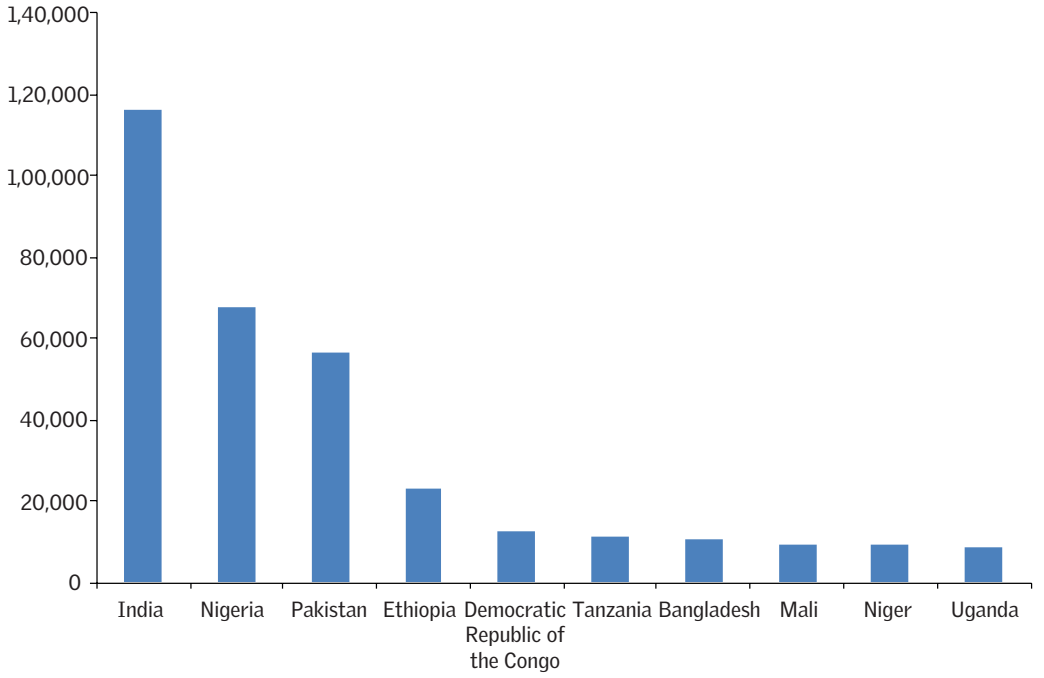
Graph 18: Top 10 countries with highest household air pollution deaths in Africa



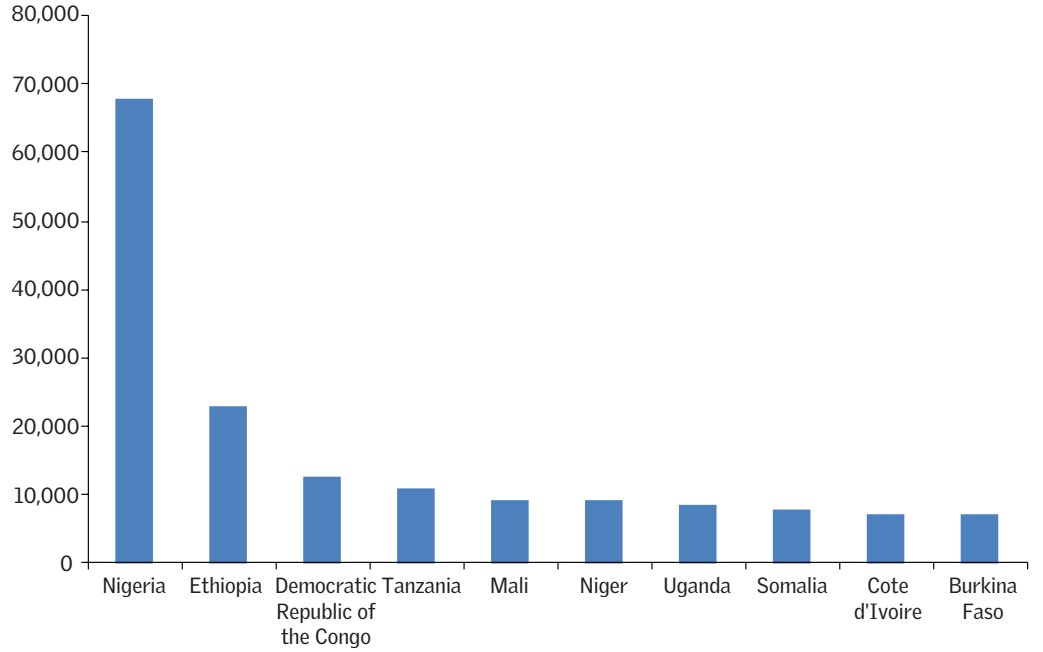
Graph 19: Household air pollution impacting infants



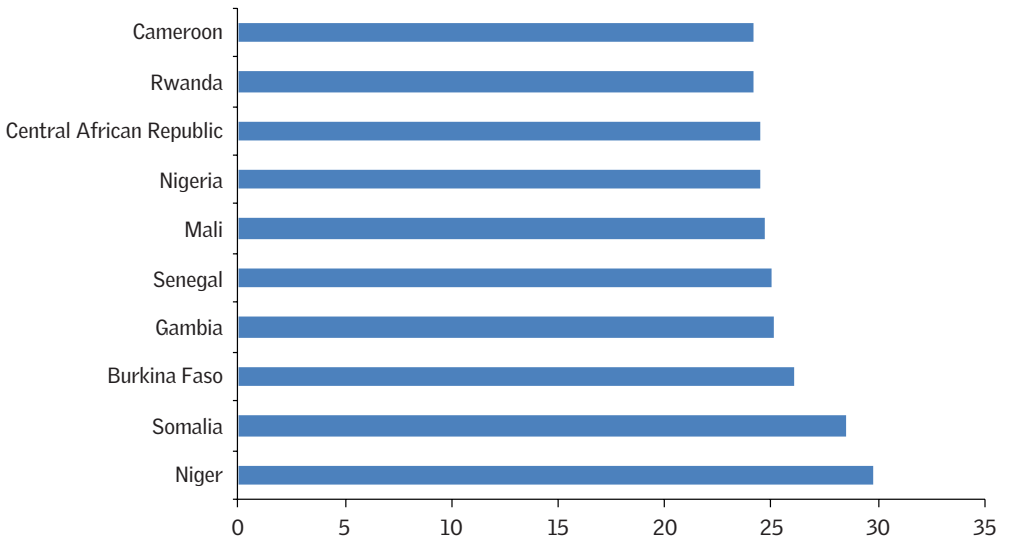
Graph 20: Top 10 countries with highest number of new-born deaths from air pollution exposure



Graph 21: Top 10 African countries with highest number of new-born deaths from air pollution exposure



Graph 22: Top 10 countries with highest percentage of neonatal deaths from air pollution exposure in Africa



Chapter 3: Tracking clean air action in Africa

What is the nature, direction and scale of action in Africa?

Against the backdrop of worsening air quality and public health risk, this compendium has tracked action across Africa. Diverse set of actions have been initiated in the areas of air quality monitoring and management, vehicle technology and fuel quality, and mobility management. Scale and scope of action varies across the region.

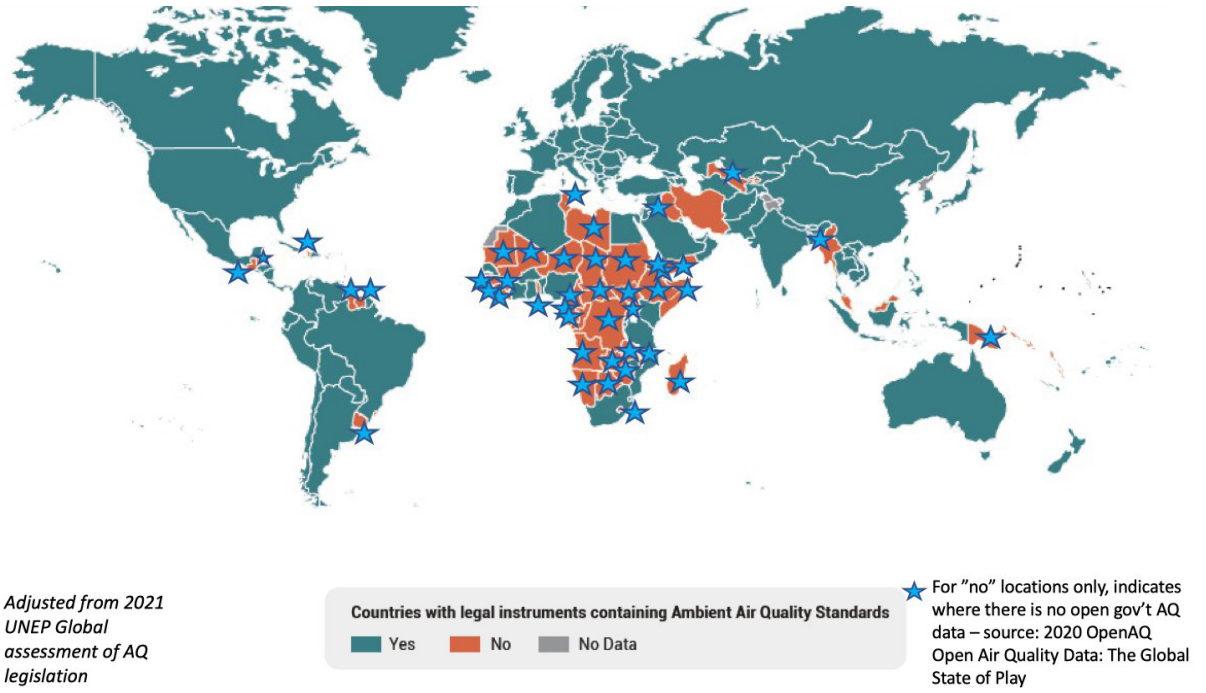
Regulating air quality

Has Africa taken the first step towards regulating air quality and adopting air quality standards to enable setting of clean air targets to guide action?

United nations Environment Programme (UNEP) has reviewed the legislations on air quality in 194 countries across the world in 2021 to assess if such instruments (national air quality act or environmental act including national ambient air quality standards) exist and have been promulgated and how these have been designed, what their level of ambition is and if they cover indoor air quality and newly emerging pollutants. This brings out sharp regional differences and the fact that most countries in Africa have not adopted legislative instruments containing ambient air quality standards. Only countries in Africa that have adopted such instruments are Algeria, Benin, Burkina Faso, Côte d'Ivoire, Egypt, Eswatini, Gambia, Ghana, Kenya, Mauritius, Morocco, Mozambique, Nigeria, Rwanda, Senegal, South Africa, and United Republic of Tanzania.

Ambient air quality standards are a regulatory measure to set the target for pollution reduction and achieve clean air. These standards are needed to provide adequate margin of safety to protect public health, vegetation and property, establish priorities for abatement and control, provide uniform benchmarks for assessing air quality at national level and impact of control measures over time, and indicate the need and extent of monitoring programmes. The standards should be health-based and uniform across the entire population and not land use based (for example weaker standards for industrial areas than for urban areas/ residential areas). Industrial areas are also densely populated and as urbanization progresses, boundaries between residential and industrial areas become porous, exposing people to high levels of air pollution.

Map 4: Countries with legislative instruments containing ambient air quality standards



Adjusted from 2021 UNEP Global assessment of AQ legislation

Source: UNEP 2021, Regulating air quality, The first global assessment of air pollution legislation, Nairobi

However, in Africa, there is a trend towards regional cooperation on air quality that has allowed some embedding of legislative instruments. These include Eastern Africa Regional Framework Agreement on Air Pollution (Nairobi Agreement), Central and Western African Regional Framework Agreement on Air Pollution (Abidjan Agreement) and Southern African Development Community Regional Policy Framework on Air Pollution (Lusaka Agreement). These agreements call for regional cooperation on the harmonization of AQS, monitoring procedures and data management. [6]

This action will require a lot more traction to strengthen air quality management.

Air quality monitoring

How prepared is Africa to generate robust air quality data to inform policy and action?

As overall air quality regulation and management remains nebulous in the region, the system of generating air quality data is also either absent or is very nascent. But there are positive developments as well.

Dakar, Senegal

Air quality management centre: Senegal is located in the westernmost part of Africa's Sahel region. The Senegalese government has acted proactively to create the Centre for Air Quality Management (Centre de Gestion de la Qualité de l'Air) or CGQA in the capital city of Dakar in 2009. The CGQA is said to be the only one of its kind in West Africa so far. It was funded by the Nordic Development Fund (NDF) and the Senegalese Government and placed under the supervision of the Direction of Environment and Classified Establishment of the Ministry of Environment and Sustainable Development. The objectives of the centre are to monitor ambient air pollution, advocate realistic measures to improve air quality, inform the public about air quality, provide reports to the authorities for decision making, and to promote establishment of a committee on air quality.[7] This is a critical step towards strengthening institutional processes for air quality monitoring and management. Since its inception, several actions have been initiated.

Air quality monitoring stations: The centre had started with five monitoring stations in Dakar in November 2009. At present, the centre has six monitoring stations, a mobile laboratory and a reference laboratory.[8] The sixth monitoring station was added in November 2017 under the Project for Transport and Urban Mobility (PATMUR) implemented by the Executive Council of Urban Transport in Dakar CETUD. Mobile laboratory with analysers enables monitoring in areas not covered by the regulatory stations.

Air pollutants monitored and guidelines: The air pollutants monitored include particulate matter (PM_{10} and $PM_{2.5}$), nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and air toxics benzene, toluene, ethylbenzene and xylenes (BTEX).[9] Based on the WHO guideline, Senegal has drafted its own air quality guidelines (see *Table 1: Air quality guideline: Senegal and WHO*). While some air pollutants have similar values as that of WHO guidelines—for example: sulphur dioxide (24 hours and annual), nitrogen dioxide (1 hour and annual) and ozone (8 hourly)—others such as CO and PM_{10} are not as stringent as WHO; except lead which is marginally marginally more stringent than WHO.

Table 1: Air quality guidelines: Senegal and WHO

Pollutants	Averaging time	Maximum limit value	
		WHO	Senegal
Sulphur dioxide (SO_2)	1 hour	500 (10 min)	-
	24 hours	125	125
	Year	50	50
Nitrogen dioxide (NO_2)	1 hour	200	200
	Year	40–50	40
Ozone (O_3)	1 hour	150–200	-
	8 hours	120	120
Carbon monoxide (CO)	1 hour	30,000	-
	8 hours	10,000	30,000 (24 hr)
Particles less than 10 micron (PM_{10})	24 hours	50*	260
	Year	20*	80
Lead	Year	0.5–1	2

Note: * is EU limit value

Source: Aminata Mbow Diokhane 2015, Centre for Air Quality Management in Dakar (CGQA), Paper presented at Conclave of Champion Cities, Centre for Science and Environment, New Delhi, April 9.

Air quality monitoring: Real-time monitoring consists of gas analysers determining pollutant concentration using a spectroscopic method. Instant alert is possible with the help of real-time data. Measurement campaigns are also done when integrated to the van. In addition, passive samplers are placed for at least 15 days and then analysed at the laboratory.

Data generation and dissemination: Data is generated and collected every 15 minutes. Out of two servers, one runs with the software for communicating between stations and the central laboratory and is used for daily export of automatic validated data and monthly export of quality-controlled data. The second server is called AirQUIS. It has been developed by the Norwegian Institute for Air Research (NILU) and is used for hourly automatic import for calculating the AQI, for performing different statistical analyses with data, and also for modelling and quality control. The AirQUIS system consists of different modules—monitoring modules, emission inventory modules, map data, background data—all stored in the oracle database. It also consists of user interface with graphics, GIS and internet connection. The internet connection is used for disseminating information to the public. Monthly, quarterly and annual air quality reports are generated and available on the website.

Air Quality Index (AQI): The AQI is used to report daily air quality. It indicates if the air is clean or polluted and the associated health concerns one should be

aware of. The AQI is calculated every day from real-time data monitored by the stations using the AirQUIS system. Five pollutants (O_3, PM_{10}, CO, SO_2 and NO_2) are used to calculate the AQI. AQI between 0 and 50 indicates good air quality and is depicted by green. Between 51 and 100 is moderate air quality indicated by yellow colour. Sensitive people like children, older people or those suffering from asthma and other lung and heart diseases might face some health problems during this time. The next category between 101 and 200 is considered unhealthy and is indicated by orange. This impacts the sensitive as well as the healthy. AQI beyond 200 is considered unhealthy and is indicated by red. During this time, emergency measures have to be taken to improve air quality.

Table 2: AQI system

Air Quality Index (AQI) values	Levels of health concern	Colours
When the AQI is in this range...	...air quality conditions are	...as symbolized by this colour
0–50	Good	Green
51–100	Moderate	Yellow
100–200	Unhealthy	Orange

Alert system: In case of pollution peaks, the air quality management centre sends out a warning so that people can prepare for it and minimize the short-term effects on their health. There was an air pollution episode from 27 February to 01 March 2015. Dakar and other parts of the county were covered by dust that hampered visibility. The daily average PM_{10} concentration exceeded three times the Senegalese limit value and 20 times the WHO limit value. The highest $PM_{2.5}$ concentration (232 µg/m^3) was measured on 27 February. It exceeded the WHO limit value by nine times. An alert was sent out on 26 February. Children, elderly and people with asthma and other chronic lung diseases were advised to remain vigilant and contact physicians if needed. This message was put up on the website and also communicated through the media and radio.[10]

Another example is from the pollution episode that started on 26 January 2016. An alert message was sent to the press and to hospitals (pneumology services) stating that the air quality is going to be very bad (red index) due to increase in desert particulate concentration and this situation could last for the upcoming 72 hours.[11]

Another particulate pollution episode was observed from 22–29 December 2017. Maximum values of PM_{10} exceeded 800 µg/m^3 in most of the monitoring stations, which indicated 'Red, very unhealthy' AQI. An alert message was published online and sent to the press and hospitals (*The air quality for today is very unhealthy*

(Red Index). Desert particulates concentration started increasing yesterday. This situation could last for the next 72 hours. Children, people with asthma and other chronic lung diseases, and the elderly should remain vigilant and contact a physician if needed).

Mobile monitoring: The centre has acquired portable devices to increase monitoring. Measurement campaigns were conducted to determine the chemical composition of the particulates. The portable devices include two particle samplers, five portable particle analysers, three vehicle pollution measuring devices, two portable multi-gas analysers and one VOC measuring device. There are plans to extend the monitoring network to the main Senegalese cities using air sensors.[12] Highest PM and NO_2 concentrations are usually observed during peak hour traffic.

Accra, Ghana

Accra, the capital of Ghana, has a population of four million. With an area of 2,592 sq. km, it is the fastest growing urban area in the country.

Air quality legislation: The Environmental Protection Council (EPC) of Ghana was set up in 1974 following the Stockholm Convention. Later, the EPC was changed to Environmental Protection Agency (EPA) by an Act of Parliament (Act 490) in 1994. Act 490 mandates the EPA to co-manage, protect and enhance the country's environment and seek national, international and multilateral collaboration in order to do so. As per Section 2 of Act 490, EPA is to develop a comprehensive environmental quality database to guide policy formulation and implementation, and to prescribe guidelines, standards and regulations relating to the pollution of air, water, land and any other forms of environmental pollution including the discharge of waste and the control of toxic substances.[13]

Air quality monitoring: In 1995, Ghana Environmental Action Plan was developed and the EPA began planning for environmental quality monitoring to ensure environmental compliance. Air quality monitoring in Ghana was initiated by the EPA in 1997 at Accra, Tema, Kumasi, Takoradi and Tarkwa with support from the World Bank.[14] Monitoring was also done in residential, commercial and industrial areas. The key parameters monitored then were PM_{10}, TSP, CO, SO_2, NO_2 and black smoke.[15] But due to frequent breakdown of monitoring equipment and reduced financial resources making data unreliable and lacking reporting integrity, the programme was discontinued in August 2001.

In July 2004, the USEPA, USAID and UNEP selected Accra as one of two African cities to benefit from an Air Quality Monitoring Capacity Building Project. Ten air

quality monitoring sites were set up including six permanent sites at residential, industrial and commercial locations and four roadside sites along major traffic routes. Sixteen air quality monitoring stations are located in Accra. Of these, three are in residential areas, one is in a commercial area, two are in industrial areas and the remaining ten are along major roads. Eight monitoring sites are located along type 'A and B' BRT routes. Monitoring follows a six-day schedule. PM_{10} monitoring is carried out for 24 hours every six days. SO_2, NO_2 and O_3 are also monitored and determined on an ion chromatograph.

High PM levels: Monitoring results by EPA showed high PM levels in roadside and commercial area monitoring stations. High PM levels are attributed to road dust, commercial activities, wind-blown dust and vehicular exhaust emissions. Despite heavy vehicular traffic, SO_2 levels measured were low due to reduction in sulphur content of the crude oil used by Tema Oil Refinery and imported fuel.[16] PM_{10} and $PM_{2.5}$ data along roadside stations exceeded the national guidelines. About 57–100 per cent of PM_{10} data collected from ten roadside monitoring stations during April and June 2017 exceeded the national ambient air quality guideline of 70 $\mu g/m^3$. During the same period, nearly 70 per cent of $PM_{2.5}$ data from the only one monitoring station exceeded the guideline value of 35 $\mu g/m^3$. [17]

Formulation of air quality standards: In 2000, National Environmental Quality Guidelines for ambient air quality (for residential, industrial and commercial areas) and stationary/point sources, among others, were developed. These guidelines were used for development projects and for compliance and enforcement purposes. These were reviewed and made draft standards in 2016. The process included formation of national stakeholder committee comprising the government, NGOs, academics, industry, among others; reviewing existing guidelines based on data collected over the years; comparison with international standards; and adoption wherever found appropriate. Measurements ranged between minutes (gases) to short-term (24 hours) to long-term (1 year).

The existing ambient air quality guidelines had 18 parameters. The draft ambient air quality standards had 29 parameters listed. Twenty-four of which were considered, including PM_{10}, $PM_{2.5}$, TSP, SO_2, NO, CO, smoke, BC, benzene, HCN, mercury and its compounds, Pb, Cd, dichloromethane, tetrachloroethane, toluene, As, fluoride, O_3, Ni, PAH, xylene, total PCB, dioxins and furans.

Stationary/point source standards: For point sources, the standards are based on source of fuel, type of energy used, fuel type (solid, liquid, gaseous, electrical), arc furnace and incinerators. The parameters include NO_x, SO_2, PM, CO, HCl, HF, mercury and mercury compounds, and lead.

The draft air quality standards are to be reviewed by the Ghana Standards Authority (GSA) before being finalized and gazetted.[18] Stationary and mobile emission standards are under consideration by EPA Board and will need validation and gazetting by the GSA.

Air quality index: EPA calculates AQI based on PM, O_3, CO, SO_2 and NO_2 data. AQI ranges from 0 to 500, with higher AQI values indicating high air pollution levels and health concern. AQI is divided into 6 colour coded categories (see *Table 3: Ghana AQI*)—green (0–50, good), yellow (51–100, moderate), orange (101–150, unhealthy for sensitive groups), red (151–200, unhealthy), purple (201–300, very unhealthy) and maroon (301–500, hazardous).[19]

Table 3: Ghana AQI

When the AQI is in this range	...air quality conditions are
Good (0–50)	No health impacts are expected
Moderate (51–100)	Usually sensitive people should consider limiting prolonged outdoor exertion
Unhealthy for sensitive groups (101–150)	The following groups should limit prolonged outdoor exertions: · People with lung disease, such as asthma · Children and older adults · People are active outdoors
Unhealthy (151–200)	The following groups should avoid all outdoor exertions: · People with lung disease, such as asthma · Children and older adults · People are active outdoors · Everyone else should limit prolonged outdoor exertion
Very unhealthy (201–300)	The following groups should avoid all outdoor exertions: · People with lung disease, such as asthma · Children and older adults · People are active outdoors Everyone else should limit prolonged outdoor exertion
Hazardous (301–500)	Everyone should avoid any outdoor exertion

Source: Emmanuel K-E Appoh 2016, Air Quality Monitoring and Health Programme in Accra, Ghana, Paper presented at the Regional Consultation on Air Quality, Clean Vehicles and Sustainable Mobility Roadmap, Centre for Science and Environment and National Environment Management Authority, Nairobi, August 24–25.

Low-cost sensors: In addition to the 16 regulatory monitoring stations in Accra, 23 low-cost sensors complement the air quality monitoring network. While 18 are Clarity low-cost sensors, five are Purple Air off-line sensors. These low-cost

sensors are located at ten sites—four permanent sites with power supply, one permanent site without power and five roadside cages without power. The Clarity sensors measure PM_{10}, $PM_{2.5}$ and PM_1. The line power units measure data every five minutes and solar powered sensors measure data every 15 minutes. The data is transmitted to Clarity for performance/troubleshooting and to AirNow-Ghana system using an API. The Purple Air sensors use SD cards for data retrieval and measure PM_{10} and $PM_{2.5}$. The line power units measure data every 80 seconds and record it in text files in SD cards (offline mode). The monitored data is transmitted to AirNow-Ghana system via FTP. The data file is retrieved every 3 to 4 weeks.

Air quality data management system: The EPA Ghana-AirNow data management system includes management of real-time data from Clarity sensors, meteorological data, historical data including Purple Air sensors running in offline mode and data query and reports, and GIS visualization from satellite data and air quality observations, HYSPLIT and AOD and pollution/Wind Roses.[20]

Sources of pollution: The major sources of air pollution are vehicular exhaust emissions with older vehicles as largest emitters, industries, open burning of waste, inefficient incineration, domestic waste, biomedical waste (dioxins and furans), road and wind-blown dust, and mercury fumes from artisanal or small-scale gold mining (ASGM).[21]

Addis Ababa, Ethiopia

Ethiopia is a landlocked country in east Africa with a population of nearly 117 million. It is bordered by Djibouti, Eritrea, Kenya, Somalia, South Sudan, and Sudan. The country lies within the tropical latitudes and is relatively compact, with similar north–south and east–west dimensions. Addis Ababa, the capital city, is located almost in the centre of the country. Ethiopia consists of high plateaus with the central mountain range divided by the Great Rift Valley. Increasing air pollution is a concern in the country. Steps have been initiated to set up real-time air quality monitoring stations in select cities and towns to develop baseline air quality data and also air quality guidelines. The Environment, Forest and Climate Change Commission (EFCCC), along with concerned stakeholders, has begun work on developing a roadmap for air quality management.

Real-time air quality monitoring: Ethiopia initiated air quality monitoring by setting up a real-time air quality monitoring station at the National Meteorology Agency (NMA) campus in Addis Ababa. Set up by Thermo Fischer Scientific India Private Limited at a cost of 5 million Birr, this station can monitor three gaseous pollutants—nitrogen oxide (NO_x), ozone (O_3) and carbon monoxide (CO).[22]

Particulate matter is not being monitored yet. The NMA plans to upgrade and install a particle pollutant monitor. Air quality data is not publicly available but is supposed to be available on demand.

There is one $PM_{2.5}$ real-time monitor set up at Black Lion Hospital compound in Addis Ababa for research purposes. It is maintained by the Addis Ababa University College of Health Science through the GEO Health Hub network. There is one $PM_{2.5}$ monitor located each at the US Embassy and International Community School with publicly available online data at USEPA AirNow website.[23]

The second Growth and Transformation Plan of Ethiopia, which is a 5-year plan, lays emphasis on air quality issues and has air quality as one of the components. There were plans to set up air quality monitoring stations in other cities of Ethiopia as well. The NMA invited bids for procurement of continuous ambient air quality monitoring station. Later, one real-time monitoring station was set up each in Hawassa and Adama. Adama and Hawasa air quality monitoring stations monitor NO, NO_2, NO_x, O_3, SO_2, PM and CO.[24] In addition to these three cities and towns, there are monitoring stations in Bishoftu, Dukam, Mekelle and Bahri-dar towns.

Air quality guideline: In 2003, Ethiopian Environmental Protection Authority and the United Nations Industrial Development Organisation had prepared the guideline for ambient environment standards (including air quality standards) for Ethiopia under the Ecologically Sustainable Industrial Development (ESID) Project. Under this, limits have been set for six air pollutants—SO_2, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and lead. Standards for compounds with non-carcinogenic and carcinogenic endpoints (compounds like benzene, benzopyrene and diesel exhaust) have also been listed. WHO guidelines have been used as reference points. It may be noted that normally carcinogens like benzene, PAH and benz(o)pyrene are harmful even at trace level. While standards for some air pollutants are similar to the WHO guidelines—sulphur dioxide (10 minutes), nitrogen dioxide (1 hour) and nitrogen dioxide (annual)—others are not as stringent as WHO guidelines. An exception is the annual $PM_{2.5}$ standard which is marginally higher than the WHO guideline.

Table 4: Air quality guidelines: Ethiopia and WHO

Pollutants	Ethiopia guideline value ($\mu g/m^3$)	WHO guideline value ($\mu g/m^3$)
Sulphur dioxide (10 minutes)	500	500
Sulphur dioxide (daily)	125	20
Sulphur dioxide (annual)	50	--
Nitrogen dioxide (1 hour)	200	200
Nitrogen dioxide (annual)	40	40
Carbon monoxide (15 minutes)	100,000	--
Carbon monoxide (30 minutes)	60,000	--
Carbon monoxide (8 hour)	10,000	--
Ozone (8 hours)	120	100
Ozone (1 hour)	---	180
PM_{10} (annual)	50	20
PM_{10} (daily)	150	50
$PM_{2.5}$ (annual)	15	10
$PM_{2.5}$ (daily)	65	25
Lead (annual)	0.5	--

Source: Guidelines Ambient Environment Standards for Ethiopia 2003; WHO guidelines

Ethiopia needs to adopt the key elements of air quality monitoring and management. These include air quality monitoring strategy (monitoring network design, leapfrog to real-time monitoring, good monitoring protocol, select pollutants and meteorological factors for monitoring, quality control and assurance for credible data, data reporting, public information system, pollution forecasting), pollution source assessment strategy (emissions inventory, source apportionment and modelling tools), exposure management, time-bound implementation of clean air action plans, and setting up of institutional process for air quality management.

Air quality management roadmap: Recently, the EFCCC and concerned stakeholders are deliberating to develop a roadmap for air quality management. This roadmap will be a rolling action plan with a clear vision and air quality target to be achieved within a time frame of five to ten years. This will be reviewed every five years and improved upon depending on the emerging situation. This multi-sector roadmap identifying critical strategies in different sectors will outline a strategic plan to assist decision-makers and other stakeholders to formulate and implement effective strategies to manage and control air pollution.

Cities of Nigeria

Nigeria is located in West Africa, on the Gulf of Guinea. It shares its borders with Benin, Niger, Cameroon, and Chad Republic.[25] Air pollution is a serious concern in Nigeria, with particulate pollution being of utmost concern in Nigerian cities.

Smog in Lagos: The earliest and the first ever smog episode in Lagos which lasted for more than six hours was reported way back in 12 October 2005 when people around Lagos woke up to a hazy atmosphere that was very unusual. The situation was so strange that some schools around Maryland, Ojota, Anthony and Ikeja had to shut down and children were sent back home. The period of smog lasted for over six hours. This led Lagos Metropolitan Area Transport Authority (LAMATA) to facilitate the Lagos Air (vehicular emission) Quality Monitoring Study (LAQMS) in February 2007.

Harmattan, episodic event: Some states and cities in Nigeria experience Harmattan from the end of November to the middle of March. This poses challenges as cities become dusty and hazy with low or poor visibility. It occurs due to the Harmattan dry and dusty trade winds that flow from the Sahara Desert over West Africa. As there is very limited monitoring, there is a dearth of data on its health impacts.

High particulate pollution and exposure: The 2016 WHO database on particulate pollution reported air quality monitoring data of 12 Nigerian cities. All cities in Nigeria had an annual mean of PM_{10} and $PM_{2.5}$ above the WHO guideline. Nigerian cities such as Onitsha, Kaduna, Aba and Umuahia were among four of the 20 African cities that reported worst air quality in the world. Onitsha was the most polluted in terms of PM_{10} and reported the highest (594 $\mu g/m^3$) PM_{10} levels. PM_{10} levels in Onitsha were 30 times higher than the WHO annual PM_{10} guideline of 20 $\mu g/m^3$. PM_{10} levels in cities exceeded the WHO guidelines by about 4 to 30 times. Kaduna had highest $PM_{2.5}$ levels (90 $\mu g/m^3$). The $PM_{2.5}$ levels in cities exceeded the WHO guidelines by about 2 to 9 times. The 2016 edition of The Little Green Data Book of the World Bank showed that 100 per cent of the Nigerian population was exposed to $PM_{2.5}$ levels exceeding WHO guidelines. The 2015 edition of the same publication however stated that 94 per cent of the population was exposed to $PM_{2.5}$ exceeding WHO guidelines.

Air quality monitoring stations: Air quality monitoring is a serious challenge in Nigeria, which has a limited number of monitoring stations. Air quality monitoring in the capital city, Abuja is done by three agencies, namely the Federal Ministry of Environment (FME) with one automatic monitoring station at International

Conference Centre monitoring CO and SO_2 levels, Nigerian Meteorological Agency (NiMET) monitoring SO_2, NO_x, CO and PM_{10} levels, and National Environmental Standards and Regulations Enforcement Agency (NESREA) with a mobile air quality monitoring station. However, power supply is reported to be a major constraint in the functioning of stations.

In addition to Abuja, NiMEt currently has air-quality measuring equipment located in Lagos, Enugu, Kano and Maiduguri. Each station is also equipped with an automatic weather station to monitor meteorological parameters like wind speed and direction, air temperature, relative humidity, and solar radiation. The data on pollutants is being collected and archived for investigation and analysis. The pollutants currently being monitored are NO_x, NO, SO_2 and CO. A preliminary analysis of SO_2, NO, NO_2, CO and PM_{10} is presently being carried out. Some stations are said to be functioning while others are not due to maintenance issues. NiMET claims it has monitored air quality data since 1993, which is archived and can be provided on request. However, the agency admits there is certainly a need for more real-time stations to have continuous air quality data.

Ambient air quality standards: In 1991, Nigeria adopted ambient air quality standards. These include TSPM, SO_2, CO, NO_x, among others, and needed revision.

The National Environmental (Air quality control) Regulations 2014 mandates ambient air quality standards for 10 air pollutants (see *Table 6: Ambient air quality standards, 2014*)

Table 5: Ambient air quality standards, 1991

Air pollutants	Ambient limits
Particulates	250 µg/m^3
Sulphur dioxide	0.1 ppm
Non-methane hydrocarbon	160 µg/m^3
Carbon monoxide	11.4 µg/m^3 or 10 ppm
Nitrogen oxide	0.04–0.06 ppm
Photochemical oxidant	0.06 ppm

Source: Federal Ministry of Environment, Nigeria

Table 6: Ambient air quality standards, 2014

Sr. no.	Pollutant	Time weighted average	Concentration in ambient air
1.	Sulphur dioxide (SO_2)	Annual	80 µg/m^3
		24 hours	120 µg/m^3
		1 hour	350 µg/m^3
2.	Nitrogen dioxide (NO_2)	Annual	80 µg/m^3
		24 hours	120 µg/m^3
		1 hour	200 µg/m^3
3.	Carbon monoxide (CO)	8 hours	5 mg/m^3
		1 hour	10 mg/m^3
4.	Particulate matter (PM_{10})	Annual	60 µg/m^3
		24 hours	150 µg/m^3
5.	Ozone (O_3)	8 hours	100 µg/m^3
		1 hour	180 µg/m^3
6.	Lead (Pb)	Annual	1 µg/m^3
		24 hours	1.4 µg/m^3
7.	Arsenic (As)	Annual	6,000 µg/m^3
8.	Nickel (Ni)	Annual	20,000 µg/m^3
9.	Cadmium (Cd)	Annual	5,000 µg/m^3
10.	Ammonia (NH_3)	Annual	0.2 mg/m^3
		24 hours	0.6 mg/m^3

Source: Federal Republic of Nigeria Official Gazette, Lagos, 26 December 2014

Nigeria needs to augment its air quality monitoring. Real-time monitoring will require rapid expansion of real-time air quality monitoring capacity. It can be combined with more affordable manual monitoring to create baseline air quality data for a wider population base. This can also be combined with other innovative techniques like using digital data and satellite imagery to map out pollution across cities. Steps should also be taken to conduct monitoring and assessment during episodic events like Harmattan. Advisories should be issued on precautionary measures to be taken by people to avoid high exposure.

Sources of air pollution: The key air pollution sources are particles from the Sahara Desert; biomass burning; use of fossil fuels resulting in gaseous concentrations of NO_x, SO_x, CO and VOCs; domestic power generators; and industrial activities. This led to black carbon episodes in Rivers State and its environs. The increase in air pollution is due to increase in density of population, resulting in increase in transportation emissions per square kilometre; increase in the number of fairly

used vehicles; road traffic system, increase in the number of household power generators, weak legislation and lack of effective enforcement, etc.[26]

Nairobi, Kenya

Air pollution is a primary concern in Kenyan cities including Nairobi. Sources contributing to air pollution include the industrial sector, energy sector, transport sector, waste disposal systems and domestic cooking activities.[27] Article 42 in chapter 4 of the Bill of Rights of the Constitution guarantees the right to a clean and healthy environment to every Kenyan.[28] The National Environment Policy, 2013 of the Ministry of Environment, Water and Natural Resources states, 'Air pollution is a leading cause of respiratory diseases such as chronic obstructive pulmonary disease (COPD), lung cancer, pulmonary heart disease and bronchitis. The effects of outdoor air pollution are compounded by those of indoor air pollution. Most households use charcoal and firewood for domestic cooking. Indoor air pollution affects both urban and rural population.' The policy adds, 'The Government will ensure compliance with air quality standards and strengthen enforcement capacity; promote efficient non-motorised, non-polluting and efficient infrastructure for mass transport system; promote non-polluting modes of transport, and promote alternative cooking stoves and technologies that are not polluting and construction of well-ventilated houses.'[29]

Air quality monitoring: Kenya needs to augment air quality monitoring. Regulatory air quality monitoring is being done by the Kenya Meteorological Department (KMD). The KMD operates an air quality monitoring station located in Mount Kenya for measuring CO_2, O_3 and MH_4 for Global Atmospheric Watch programme.[30] Mobile air quality monitoring is also being carried out. NEMA has set up an air quality laboratory. In absence of regulatory air quality monitoring stations, affordable low-cost air quality monitors are important to generate baseline data, sensitize the population, raise awareness on increasing air pollution levels and advocate for clean air in cities.

Air quality regulations: According to the Constitution of Kenya, air quality is devolved to counties while the central government retains overarching role of policy guidance and action. Air Quality Regulations were gazetted in April 2014.[31] The regulations provide standards for management of air quality for several categories of air pollutant sources namely stationary sources, mobile sources and occupational air quality. It also prescribes ambient air quality standards.[32]

Monitoring through low-cost sensors: Low-cost air quality sensors have the potential to bridge this data gap. Though these are not highly accurate as compared

to regulatory monitors, they are economical in terms of cost (ranging from $100 to $1000), and easy to install and operate. UNEP has developed an affordable air quality monitoring unit based on electrochemical sensors for gases and Optical Particle Counters (OPCs) for particulate matter. It was piloted in Nairobi and deployed in six sites (Kibera Girls Soccer Academy in Kibera informal settlement; Viwadani community centre in an informal settlement in an industrial area of Nairobi; St. Scholastica near Thika highway; UNEP headquarters in Gigiri; All Saints Cathedral School close to Mbagathi road and several small shops and industries; and Alliance Girls School located in Kikuyu town, north of Nairobi, as an urban background site) in late April 2016.

The successful deployment showed that these low-cost affordable monitoring units are able to retrieve data for processing, verification and visualization; data collected is sufficiently accurate to determine the state of air quality, pollution hotspots and pollution sources; network can be implemented and maintained locally and units are deployable in cities with limited infrastructure and difficult operating conditions. Maintaining data reliability and increasing accuracy would require access to calibration of the network alongside reference instrumentation at one location.[33]

Source apportionment study: Vehicles, industries, road dust, waste, etc. are prime sources of air pollution in Nairobi. According to a source apportionment study, traffic and mineral dust are the top two air pollution sources contributing 39 per cent and 35 per cent of particulate pollution in Nairobi. The other sources include mixed factor (13 per cent), industrial (7 per cent) and combustion (6 per cent).[34] All these sources will require mitigation strategies and actions to reduce air pollution levels in the city.

Chapter 4: Emissions standards and fuel quality: Africa roadmap

As motorization is picking up, is Africa accelerating action to set tighter benchmarks for vehicle technology and fuel quality?

While African cities are extremely vulnerable to air pollution, especially to emissions from ageing and outdated vehicle technologies, the spotlight on health impact of vehicular pollution in Africa is particularly important as this region is most vulnerable to import of old and used vehicles. Vehicles are among the most rapidly growing sources of pollution across Africa and pose a very complex challenge. They are responsible for very high exposure as vehicular emissions take place in the breathing zone of people.

People living or working in close proximity to heavily polluted roadways have very high levels of exposure. Vehicles emit tiny and toxic particles and deadly carcinogens. Studies show that traffic related air pollution is associated with increased risk of pre-term births,[35] smaller brain size, low-birth weights[36] among infants and increased risk of heart disease. In fact, a 2017 UNICEF report mentions that air pollutants inhaled during pregnancy can cross the placenta and affect the developing brain of a foetus, with potentially lifelong effects.[37]

Studies by the US-based non-profit Health Effects Institute show that in densely populated developing Asian cities, as much as 50 per cent of the population lives or works near roadsides. The maximum effect of vehicular pollution is up to 500 metres from a roadside. There can therefore be tangible health benefits from reduction in vehicular emissions. There is very little assessment of the health impact of vehicular pollution in cities of Africa.

Motorization in Africa: Motorization in Africa is in its early stages of growth and the baseline stock is still much lower than that in rapidly growing developing countries. According to Deloitte's 2016 Africa Automotive Insights report, there were 42.5 million vehicles in use in Africa in 2014. This increased to 45 million as per International Organization of Motor Vehicle Manufacturers (OICA) 2015 data. South Africa had the highest share with 21.4 per cent, followed by Egypt with 12.8 per cent, Algeria with 12.4 per cent and Nigeria with 8.4 per cent.

GUIDING PRINCIPLES FOR AFRICA ROADMAP FOR CLEAN AIR AND CLEAN VEHICLES

Michael P Walsh, International Vehicle Technology Expert and Member emeritus, International Council on Clean Transportation

Vehicles affect our lives in many different ways. They are a major source of CO_2, whose impact on climate change is well recognized. They are also major sources of hydrocarbons and NO_x, and also contribute to ozone, which is an increasingly serious problem in many parts around the world. They are also important from the standpoint of energy security. They tend to be major consumers of oil and increasingly some alternative fuels, so an increasing vehicle population is worrisome. Vehicles are so popular because they provide us with many conveniences and improve the quality of our lives in many ways. They are also important for the economy in many countries and, as we heard from Ethiopia, they are important from the standpoint of public safety.

Four major elements must be addressed to clean up the vehicle fleet. Vehicle technology is important and getting state-of-art technology in vehicles can reduce their emissions by over 90 per cent compared to uncontrolled vehicles. But before use of technology can be effective, cleaner fuels are needed. Low-sulphur fuel is critically important to go to the next generation of control. Fuels are important for many reasons. Whatever vehicle technology is used, it is important that we maintain those vehicles. And that is a special challenge especially in some parts of Africa where it is very difficult to get spare parts for vehicles. But it's a critical element that needs to be addressed. Finally, transportation and land use planning are very important, walking and cycling need to be promoted instead of motorized transport. Where we have good public transportation, it is very critical to build a comprehensive strategy.

Cleaner fuels are needed as they directly affect emissions. A great milestone has been achieved as there is 100 per cent lead-free gasoline around the world. Now we need to pay attention to high sulphur fuels. High sulphur fuels emit SO_2 or sulphates from tailpipe and can immediately impact emissions from vehicles, and they can disable the pollution control technology. The higher the sulphur level, the poorer the performance of the catalytic converter or a diesel particulate filter. While designing vehicle pollution control programmes, it is important to adopt policies and measures that reduce conventional air pollution, toxic air pollution, noise and greenhouse gas emissions in parallel. Vehicles and fuels should be treated as a system. Vehicle technology is directly related to fuel quality and should be looked at from a systems approach.

UNEP has done tremendous work by focusing on used imported vehicles. Most of Africa has very weak or even no policies yet in place to deal with the problem of used vehicles. It's critical that these imported used vehicles are dealt with.

Health impacts of vehicle emissions are very significant and are worsening in some countries. As we heard earlier, the vehicle population in much of Africa is relatively minimal (100 or 150 vehicles per 1000 people compared to 800 vehicles per 1000 people in the US) but it is projected to grow in the future. Therefore, we have to take strong actions fairly quickly.

Stringent vehicle standards in combination with cleaner fuels can have a major impact on offsetting emissions from the growing vehicle fleet. The lack of cleaner fuels and stringent vehicle controls means that we are condemning future populations to serious adverse health impacts. Once we get dirty vehicles on the roads, they tend to stay around. In economic terms, the analysis consistently found that the benefits of cleaner vehicles and fuels outweigh their cost. The costs of control are quite modest compared to the costs of adverse health impacts and impacts on the environment.

UNEP's comprehensive study of used imported vehicles has led to key recommendations for addressing the issue. First of all, harmonized regulations can be and should be developed at a global or regional level where countries in a region try to work together. Same can be said for imported used vehicles and trying to have a regional approach can be very helpful there. Used low and zero emission vehicles should be promoted. In dealing with used vehicles, there is a responsibility both for the exporting as well as the importing countries. Exporting countries also have to impose a certain discipline and not be sending their worst vehicles to poor countries just because there may be a demand for those vehicles. So, exporting and importing countries have a shared responsibility.

Electric vehicles are really our hope for the future in terms of both urban air pollution and climate change. They have an especially high potential in Africa which has such a high proportion of renewable fuels to generate clean electricity with.

A strong implementation and enforcement mechanism should be introduced to check compliance and enforcement of the agreed regulations.

Excerpt from the Pan Africa Network meeting organized by the Centre for Science and Environment (CSE) on 21 October 2021

A 2014 World Bank estimate shows that the vehicle ownership rate in Africa was still much lower than the world average and the average in high-income countries. In 2012, the only countries exceeding 50 cars per 1000 people were South Africa, Botswana, Mauritius and Namibia. According to OICA, vehicle ownership is expected to increase by 31 per cent.[38] Increasing vehicle ownership has been observed in a few countries, including Libya, Mauritius, South Africa and Botswana.[39]

Key urban centres are witnessing rapid increase. In Kenya, where nearly 30 per cent of all vehicles in the country are in its capital city Nairobi alone, it is estimated that the car fleet will double in just six years. In Lagos, Nigeria, it is estimated that if the ownership rates grow from 0.05 to 0.06 per capita between 2010–25, there will be an 80 per cent increase in vehicle numbers. In Ethiopia's capital Addis Ababa, even if the base numbers were small the fleet increased by 6.6 per cent in 2015 as compared to 2014.

Without its own well-established vehicle-manufacturing base, Africa has become hugely dependent on vehicle imports. South Africa has some manufacturing base while Nigeria and Ethiopia are setting up their assembly capacity.

Dieselization in Africa: Within the context of used-vehicle imports, it is important to understand the state of dieselization in Africa. There are special concerns around the toxicity of diesel emissions. The International Agency for Research on Cancer (IARC) of the WHO has reclassified diesel exhaust as a Group 1 carcinogen. Diesel exhaust is now in the same class of deadly carcinogens such as asbestos, arsenic and tobacco for their strong link with lung cancer. Diesel vehicles also emit several times higher particulate matter and nitrogen oxides than petrol vehicles. Moreover, new science has now implicated black carbon, the dark fraction of particulate matter, for enhancing climate impacts as well. Most of the diesel particulate core is the dark matter that absorbs light and heat and warms up the climate and fouls up our lungs.

High black-carbon emissions from the explosive increase in diesel vehicle numbers, use of high- sulphur diesel, outdated vehicle technology and expansion in road-based freight traffic have added to the local health as well as global climate risks. Black carbon is also co-emitted with a range of other toxic and warming gases. This link between local and global impact of diesel particulate now changes the geo-politics around the diesel emissions mitigation as the policies and action on diesel transport vary widely across vehicle-producing and vehicle-importing nations in developed and developing countries.

As high-income countries are now more focused on phasing out diesel cars from city centres and are even planning a complete ban on diesel cars in future, there are additional concerns that a huge fleet of discarded diesel cars and SUVs from these countries will get dumped in Africa.

Diesel consumption in the region is largely driven by the high share of commercial, freight and public transport that is not easily substitutable. The share of cars is still lower, but the share of diesel cars is increasing in the region due to price difference in favour of diesel. The comparative share of diesel is very high in countries with a huge difference in prices. In several countries, including Angola and Madagascar, the share of diesel in total fuel consumption is around 70–80 per cent. Countries with similar prices for diesel and petrol have lower consumption of diesel. For instance, in Botswana, Namibia, Lesotho, etc., where the prices for petrol and diesel are similar, the share of diesel consumption is around 50–55 per cent. Nigeria is the best-practice country in terms of fuel pricing; petrol is kept effectively cheaper than diesel. This has helped eliminate dieselization of cars and kept the share of diesel consumption fairly low. Share of diesel consumption in total fuel consumption is only 16 per cent.[40]

Data from studies carried out by Demiss Alemu of the Addis Ababa Institute of Technology and the Federal Transport Authority in 2012 show that dieselization is pushing the light-duty vehicles market towards bigger engine sizes which consume more diesel and generate more emissions. Ethiopia, like other African countries, is dieselizing without clean diesel. This has serious implications for their air quality and public health. African countries will have to adopt improved fuel quality and emissions standards to curb dieselization.

Transition towards clean fuel and vehicles: Leaded petrol was a major challenge for Africa. In 2002, a partnership for clean fuels and vehicles (PCFV), formed during Johannesburg World Summit on Sustainable Development, identified three priorities—elimination of lead in petrol, reduction of sulphur in diesel, and clean vehicles and technology. When PCFV was formed in 2002, only Sudan in Sub-Saharan Africa was using unleaded petrol. Later all of Africa, except some parts of Algeria, was using unleaded petrol. At present entire Africa is lead free.
Supply of low-sulphur diesel is also a priority. Countries had very high sulphur levels in diesel—up to 10,000 ppm. East African countries are gradually moving to low sulphur diesel. Morocco, Tunisia and Mauritius have met the 50 ppm target set by the PCFV. Five more countries—Kenya, Uganda, Rwanda, Burundi and Tanzania in east Africa—moved to 50 ppm from January 2015.[41]

Low-sulphur diesel transition in Africa: African countries need quick transition to low-sulphur fuels and improved vehicle emission standards. Developed countries have adopted 10 ppm sulphur fuels. But, in Africa, while some countries have implemented 50 ppm sulphur fuels, many others are still struggling to do so. The average sulphur levels, particularly in diesel fuel, are very high and reach up to 10,000 ppm. PCFV is working towards lowering sulphur levels in fuels by improving refinery technology and fuel import standards in Africa. According to UNEP, low-sulphur fuels are critical to lowering direct emissions of PM from on-road traffic.[42]

Morocco is the most advanced African country in terms of low-sulphur fuel adoption. It implemented 50 ppm sulphur diesel in 2012 and became the first African country to adopt 15 ppm in 2018. Mauritius has also adopted 50 ppm sulphur fuels.

The next phase of transition to low -ulphur diesel in the Africa region began in 2015, five East African countries—Burundi, Kenya, Rwanda, Tanzania and Uganda—adopted and implemented 50 ppm diesel sulphur fuel. Since then, there has been gradual progress with Ghana, Malawi, Mozambique and Zimbabwe implementing 50 ppm diesel sulphur fuel in 2017 and Benin, Eswatini, Lesotho and Namibia doing the same in 2019 (see *Map 5: Transition to low sulphur diesel in Africa* and *Figure 1: Africa progressing towards low-sulphur diesel*).[43]

Map 5: Transition to low-sulphur diesel in Africa

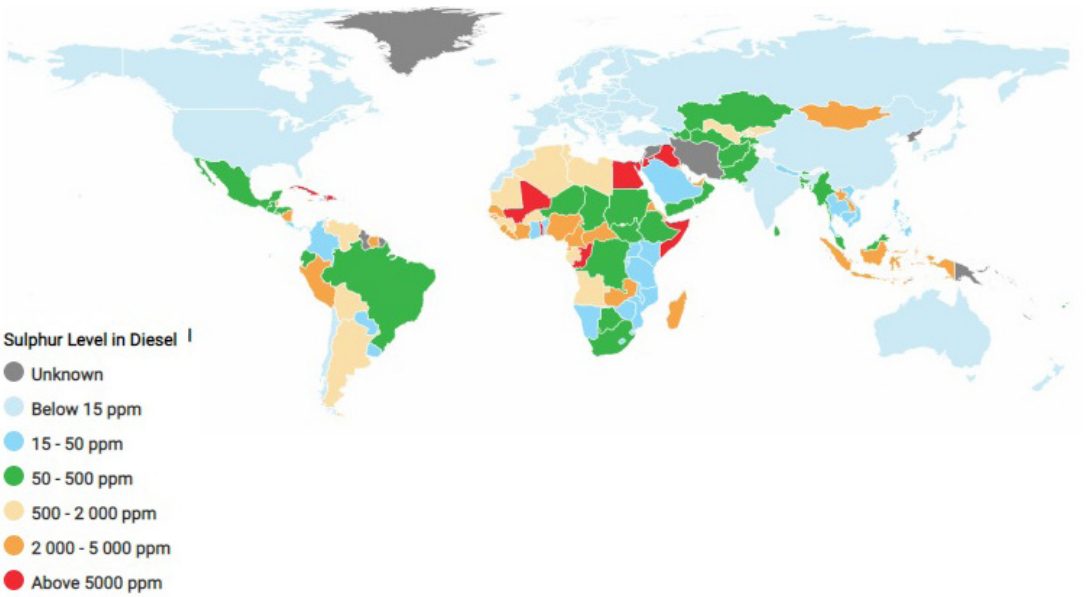
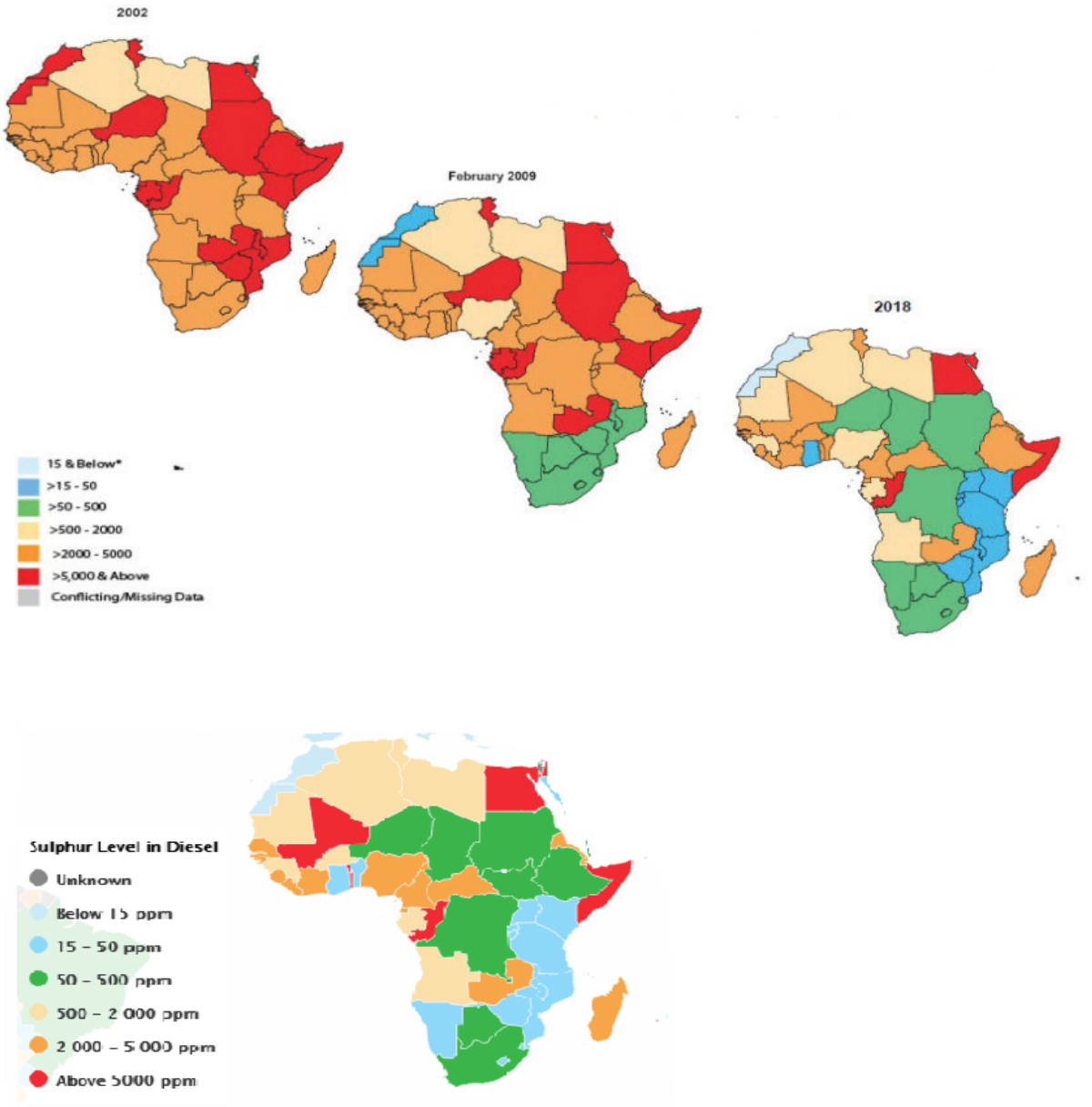


Figure 1: Africa progressing towards low-sulphur diesel



Source: UNEP

Nigeria moved towards adopting low-sulphur fuel and issued a notification for low-sulphur diesel (50 ppm) and petrol (150 ppm) in April 2017. However, implementation was delayed. But Nigeria has a unique strategy for curbing dieselization. In Nigeria diesel is priced higher than petrol. This has been effective

in stopping dieselization of cars. In West Africa, nearly all the countries use diesel with sulphur in the range of 1,000–10,000 ppm. Ethiopia is drafting a low-sulphur fuel quality roadmap.

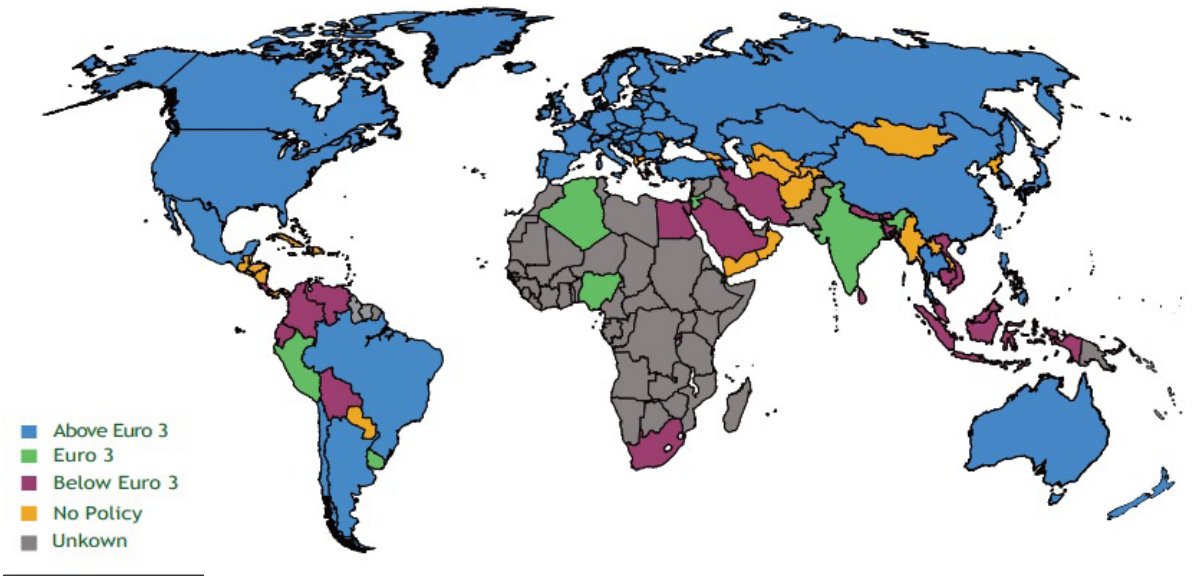
In southern Africa, Botswana, South Africa, and Zambia have fuel quality with diesel sulphur levels in the range of 50–500 ppm.[44] Other countries such as Lesotho, Malawi, Mozambique, Namibia, Eswatini, and Zimbabwe have moved to 50 ppm sulphur fuels. Among these countries, Botswana and South Africa are aiming for 10 ppm sulphur fuels. But the timeline is not clear.

Though a few West African countries have already moved to low-sulphur fuel, the remaining have been directed to adopt low-sulphur fuel by the Economic Community of West African States (ECOWAS). A meeting of ECOWAS was held in February 2020 to push for unified regional improved fuel and vehicle emission standards to address climate goals. It was decided that a shared regional standard for low-sulphur petrol and diesel, based on Euro IV emission standards, would commence in January 2021. In case of imports outside ECOWAS, similar standards for regional refinery production would commence by 2025.[45] Other African regions will need to deliberate and fasten adoption of low sulphur fuels.

Vehicle emissions standard: As fuel quality is languishing in most of the continent, progress on emission standards is slow. As of now, Algeria and Egypt (only for public buses) have Euro III emission standards. South Africa and Nigeria are at Euro II standards. South Africa planned to implement 10 ppm fuel by 2017. Nigeria is yet to implement Euro III standards.

Egypt, Kenya, Morocco and South Africa have Euro II standards and Tanzania has Euro I standards only for buses (see *Map 6: Very few African countries have emission standards for vehicles*).[46] West African countries as directed by the ECOWAS have to adopt shared regional standard, which are the same as Euro IV standards.[47] Zambia is in the process of developing vehicle emission standards. The country plans to adopt Euro III and then gradually move to Euro IV. The draft standards are to be approved by the Zambia Bureau of Standards. Ethiopia is drafting emissions standards along with low-sulphur fuel quality roadmap.

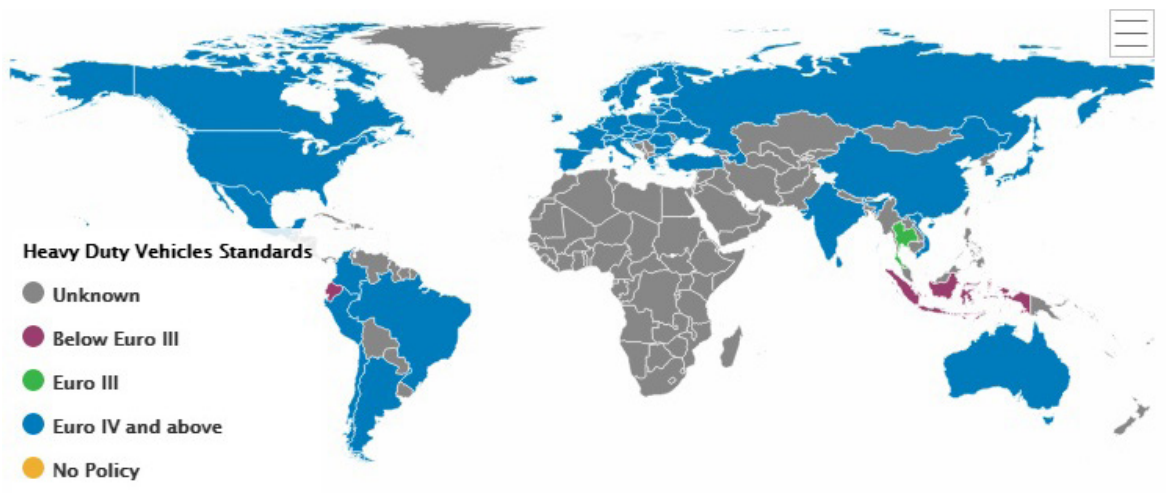
Map 6: Very few African countries have emissions standards for vehicles



Source: UNEP

There is not much information about heavy-duty vehicle emission standards in Africa except that Egypt and Tanzania have Euro III standards for public-sector buses and Euro I for other buses (see *Map 7: Heavy-duty vehicle emission standards*).

Map 7: Heavy-duty vehicle emission standards



Source: UNEP

EMERGING ROADMAP FOR CLEAN VEHICLES, CLEAN FUELS AND ELECTRIC MOBILITY FOR TRANSITION TO ZERO EMISSION VEHICLES IN AFRICA

Amos Mwangi, Programme Management Assistant, United Nations Environment Programme

Africa is still very young in terms of its motor vehicle fleet. But the projection shows very high growth of the vehicles fleet up to 2050. Most of the countries at present don't have motorization rates higher than 100 vehicles per 1000 population. Projections show that by 2050, vehicle fleet will be doubled. Motorcycle fleet is growing at a higher rate. In Kenya, the motorcycle fleet has surpassed the light duty vehicles fleet. Similarly, in Togo, many motorcycles are added annually to the fleet. Many vehicles being added to the fleet in the continent are more than 8 years old. In Tanzania also the bulk of the fleet is more than 8 years old. In Togo, nearly 17 per cent of the vehicle fleet is more than 20 years old. Nearly 85 per cent of the fleet is more than 10 years old. Source apportionment study in Nairobi shows 39 per cent emissions come from traffic.

A SLOCAT partnership study showed the share of walking, cycling and public transport trips in select African cities and found a big percentage of people using NMT, public transport and electric transport in Africa. In South Africa, the number of personal vehicles is increasing. There is a mindset issue where people just want to keep driving. There is a tradition in Africa that you go to school, get a job and then acquire a car. At times, the perception out there is walking and cycling is for the poor. Governments have to incentivize cycling and walking and advocate for their benefits so that people adopt them as their mode of choice.

In 2002, UNEP started the PCFV and worked on phasing out leaded petrol globally. There were 117 countries that were still using unleaded petrol when this was started. Recently, a big milestone was achieved with total phase out of lead in petrol globally. The last country using leaded petrol was Algeria in Africa.

UNEP has been working on cleaning up fuels in terms of lowering the amount of sulphur in fuels, especially in diesel. East Africa sub-region and the southern African countries have made some progress. The ECOWAS sub-region also adopted 50 ppm sulphur fuels beginning January 2021. But some of the countries have not yet moved. So, the ECOWAS Commission is now working on going to the countries and creating awareness. Once that is done, the countries will be expected to implement low-sulphur fuels. The low-sulphur fuels directive was implemented with vehicle emission standards. Vehicles are dealt with as a system.

Our used vehicle report looked at global vehicle flows and a complementary report that was done by the Dutch also looked at the extent and quality of vehicles that was coming to Africa. Damning evidence was found, such as some of the vehicles had hundreds of kilometres on the odometer even before they were imported to Africa. An imported car is expected to stay for 15 to 30 years. So used vehicles which are not of good quality should not be allowed to be imported. Vehicles are coming from Asia, Europe and US. Fourteen million used vehicles were imported into Africa between 2015 and 2018. Nearly 80 per cent of these used vehicles were imported by low income or developing countries. Half of these vehicles actually came to Africa from Europe, Japan and US. Bulk of the countries in Africa have no emission standards. This is now going to change as ECOWAS sub region has now decided to adopt Euro IV minimum requirements in both LDVs and HDVs. This report also used several matrices such as vehicle emission standards, age limits and fiscal policies to promote imports of better used vehicles. Most of the countries in Africa were ranked as very weak. It means countries have age limit of beyond 8 years, or they had no vehicle emission standards. Lot of work needs to be done in this sector.

We also need to look at the kind of public transport people are using, whether it is operating on clean technology, as soot that might come from the buses used for public transport actually affects the people who are using NMT. As part of this work, we reached out to authorities in Lagos, Dakar, Nairobi, Dar es Salaam and we assisted them. We have helped cities carry out cost-benefit analysis of soot-free buses they can include in their BRT systems. Electric mobility is another area of work. We are focusing on two- and three-wheelers as they are a big thing in Africa. As part of the electric mobility programme, we have a global working group, regional support and investment platform, and finally country projects. Eighteen African countries have already signed up through their GEF allocation or as part of the UNEP programmes. They have demonstration components for different vehicle segments.

Excerpt from the Pan Africa Network meeting organized CSE on 21 October 2021

Nigeria

Towards implementation of low-sulphur fuel and adoption of Euro IV emission standards as per the ECOWAS decision: Adopting emission standards and fuel quality roadmap are important to curb toxic emissions from vehicle stock. Clean fuel is the critical first step to bring more advanced vehicle technology and reduce emissions.

Nigeria has effectively curbed dieselization with fuel pricing policy. Higher price of diesel fuels has helped lower use of diesel cars in Nigeria. This is a critical step as the country imports mostly used, old vehicles. Since these old vehicles are based on old diesel technology and use poor quality fuel, it would have significantly escalated public health risk. But commercial vehicles are still on diesel. Diesel use in buses and trucks is also high and this segment attracts more new vehicles. Nigeria needs clean diesel and emissions standards for vehicles.

It is important to address diesel emissions as poor-quality diesel harms public health and climate. The International Agency for Research on Cancer of the WHO has reclassified diesel exhaust in Group 1 of carcinogens for definite links to cancer, putting it in the same bracket as tobacco. The European emissions standards that Africa and Asia follow allow diesel cars to emit three times more nitrogen oxides and several times more particulate matter compared to petrol cars. Nigeria therefore will have to quickly move to clean fuel and stringent emission standards to address diesel emissions from all sources.

Nigeria has adopted Euro III emission standards. The country moved towards adopting low-sulphur fuel and took out the notification for low-sulphur diesel and petrol. Nigeria adopted low-sulphur diesel at 50 ppm and petrol at 150 ppm

in April 2017. However, the implementation was delayed. The country should adopt Euro IV emission standards. Nigeria has adopted clean vehicles and fuels regulations like other countries in the ECOWAS region. However, according to the media reports, sulphur in petrol and diesel remained 20 and 30 times higher than the standards.

Fuel import is increasing in the country. According to Nigeria Bureau of Statistics, petrol import increased from 17.3 billion litres in 2017 to 20.14 billion litres in 2018 and 20.89 billion litres in 2019. Petroleum import cost was reported to increase three times from N289.46 billion in first quarter of 2019 to N837.67 billion by second quarter. Imported fuels are blended (dewatering, re-gassing and desulphurization) as per the standards set by the Standards Organisation of Nigeria (SON) for cost optimization. Fuels contain high sulphur content of 1000 ppm.[48]

It is important to note that lack of local refining capacity in Nigeria hampers production of low-sulphur fuels. Despite having 2.5 million low-sulphur content and high API gravity daily barrels of oil crude drilled from the Niger Delta by Shell, Chevron, Exxon and other energy giants, Nigeria has to import refined high-sulphur cheaper fuels from Europe as the state-owned refineries are non-functional.

There is however hope from new local refineries which are being set up and are expected to boost low-sulphur fuels production. The government in November 2020 commissioned the first phase of a 5,000 bpd modular refinery in Ibigwe, Imo State which is expected to produce 271 million litres of kerosene, diesel, naphtha and HFO annually. Others include Dangote-owned 650,000 bpd refinery in Lagos expected to be completed this year and a 200,000 bpd refinery owned by BUA to be set up in in Akwa Ibom.[49]

Nigeria needs to implement Euro IV emissions standards for all new vehicles and Euro IV fuels for all new and on-road vehicles and set up local refineries or upgrade and produce low-sulphur fuels. It is important to link fiscal solutions with stringent emissions standards. Fiscal strategy for clean fuel fund (direct tax incentive for import of clean fuel; differentiated retail prices for clean and dirty fuel and revenue from higher tax to go to clean fuel fund; and even a small tax on each litre of fuel sold can help to offset costs) and additional and differentiated tax on all cars can help bring more revenue for clean fuel fund. It is more cost effective to design and implement the complete system in one step.

NIGERIA – EVOLVING ROADMAP FOR VEHICLE EMISSION CONTROL MEASURES AND FUEL QUALITY

Jelani Aliyu, Director General, National Automotive Design and Development Council, Nigeria

National Automotive Design and Development Council (NADDC), Nigeria is a government parastatal authority directly under the Federal Ministry of Industry, Trade and Investment. Our core mandate is to develop the local automotive sector in terms of promoting local production and discouraging import of vehicles from other countries. Each time a fully built vehicle is imported, it means those jobs which could have been created here to add value to the local economy have been taken away. We are implementing the National Automotive Industry Development Plan which is a set of incentives, programmes and policies to develop the local automotive sector.

In the 70s and 80s, Nigeria had quite a few assembly plants of Peugeot, Volkswagen, Leyland and production figures of about 141,000 vehicles per year. Local content too was growing. About 40 per cent local content was with Peugeot, parts were coming from across the country. Things were already looking up and the hopes were that it would only get better. But in 1986 the price of crude oil dropped from $27 per barrel to below $10 per barrel and because Nigeria was so dependent on crude oil, the whole economy went into a recession overnight. Nigerians were unable to buy those new Peugeots and Volkswagens and they had to resort to buying used vehicles from Belgium and the US. All those companies had to close down as the market dried up and they left Nigeria for other clients. So, from 140,000, instead of growing, the production grounded to a halt, to virtually zero. The Federal government knew that this couldn't be allowed to continue and automotive production had to be restored. Therefore, the NAIDP was strategized by this agency and got approval for implementation. NAIDP is a set of incentives with five key elements—investment and promotion, infrastructure development, improvement of standards, skill development and market development.

The auto policy is to discourage imports with 70 per cent duty and tariff. Nigeria asks 10 per cent duty on the kits for SKD, while it asks for zero duty on CKD, so that disparity can be created. Work is being done towards a 10-year tax holiday for automotive companies. Auto policy is being reviewed to give a legal framework. The bill is expected to be passed very soon.

Nigeria has a combined investment figure of around 1 billion USD by these vehicle assemblers. Most of the assemblers, with the exception of Honda, are indigenous companies that have partners from overseas. Honda is the only OEM in the country. West Africa is assembling HR-V. There is Peugeot and Innosan. Innosan is an indigenous car manufacturer here. Others like Kojo motors and Mikano LSD have partners such as Toyota so they are assembling those foreign makes in Nigeria.

Gas powered, auto gas powered and electric vehicles are being looked at in Nigeria. The government inaugurated the National Gas Expansion Programme as Nigeria has the largest deposits of natural gas in Africa and is one of the top 10 in the world. Currently a lot of that gas is flared. The government is trying to use natural gas to restore the economy. Especially to power transportation solutions as gas, whether CNG or LPG, burns cleaner than both diesel and petrol and is better for the environment. That's a huge programme that has been initiated and implemented by the Federal government. And NADDC is responsible for the automotive sector and has a big stake in it on several fronts. An awareness campaign to enlighten people on the benefits and safety of use of autogas in vehicles was started and had on display a number of vehicles that work on autogas, some of them converted. Not only in Nigeria are we working towards converting petrol or diesel vehicles to gas, some of the stakeholders or assemblers are already producing gas powered vehicles out of the factory. This will add significant value to cleaning up the air as we all know Nigeria is one of the countries that has signed the Paris accord on the mitigation of GHGs and we believe adopting gas and electric would really help us achieve those targets very quickly.

In early 2021, Hyundai Nigeria unveiled the first ever Nigerian assembled electric vehicle, Hyundai Kona EV. This is a remarkable new electric vehicle with a range of about 482 km on a single charge and is assembled in the old Volkswagen factory. Peugeot in Kaduna in the northern part of the country and Volkswagen in Lagos on the southern coast sold off their facilities when they left and now those facilities belongs to Hyundai Stallion who are representatives of Hyundai in Nigeria. Jet systems company has also introduced 100 per cent electric delivery vans and are doing test runs with GIG logistics, one of the largest courier and logistics companies in Nigeria. With right results, it will be scaled up and used in these types of vehicles across the country. Vehicle assembly plants are being put up. Four-wheeler trucks are being put together in Lagos.

Like NAFTA, there is an agency here in Nigeria which makes sure food and drugs meet minimum global standards. A similar agency will be opened for components. That's why three automotive testing centres have been built up in Zaria, in a university's material testing laboratory in Lagos, and next to the Lagos Polytechnique, an emission and component testing centre. Equipment has already been installed in these centres. As soon as these are up and running, any component, spare parts or vehicles to be sold in Nigeria must meet minimum emissions standards and minimum standards of efficiency and durability.

Service hubs have also been built to ensure that vehicles are serviced at a professional level. There are three service hubs in the north, east and west part of the country. Six automotive training centres have been built, one in each geopolitical zone. Nigerian youth will be empowered especially in new types of technology that includes gas, auto gas and vehicle electrification so that necessary skills for creating a comprehensive ecosystem in the repair service and maintenance of gas and electric powered vehicles can be done. Three automotive industrial parks in Kaduna, Oshobo and Nnewi with necessary infrastructure are being set up. These will be PPP projects where potential investors of either components or vehicles themselves will come in and co-develop the facilities. Vehicle financing schemes are being worked on along with talks with three local banks which will provide single digit auto finance for vehicles that are either assembled or made in the country.

Hyundai has started assembling Hyundai Kona electric. When we started promoting this idea, we started discussions with different stakeholders. The argument came up that Nigeria is an oil producing country and we do have our challenges with electricity. The question is how we will power these electric vehicles when there are already problems of electricity in homes and offices? So we went ahead and developed 100 per cent solar-powered electric vehicle charging stations and commissioned two of them. One in Sokoto in north-western part of the country. The second one is in Lagos in the south-western part. We are working on the third one in the south-eastern part. We decided to locate these solar-powered charging stations in universities: Foreign University in Sokoto, University of Lagos and one in the south-east in University of Nigeria in Enugu. We have these solar powered charging stations operating and students are actively part of the monitoring and evaluation teams at these universities to understand the technologies and come up with even better Africa-applicable solutions.

LPG gas expansion programmes are going on with fronts to convert the existing vehicles, especially the taxi fleet to gas to promote the production of gas-powered vehicles while out of the factory. We will be leveraging skill centres and upskilling young Nigerians in technology related to autogas so they know how to diagnose the problems and fix them, and how to service these gas-powered vehicles. We are also promoting production, even if it is assembly of the converting kits themselves. We are also talking to potential investors on setting up gas dispensing stations. We are doing the same thing with electric vehicles. We have also already begun discussion with one of the major petrol station companies in the country to have them transitioned into providing electric vehicle charging stations.

Work has also begun on the electric vehicle policy which will guide the development and sustainability of the electric vehicle ecosystem. Overall, we believe that Nigeria presents an unparalleled destination for strong automotive companies and an opportunity to be part of an exciting journey in the provision of relevant advanced and value-added transportation solutions for the upliftment of lives of millions of people. This we believe is a time when the global automotive industry is exponentially revolutionary in its quest for the advancement of humanity and sustainability of the planet's natural ecosystems. We see Africa as a huge opportunity for advanced technology, especially that which has to do with the protection of the environment. We look at the first, second and third industrial revolutions and you can arguably say that Africa has been left behind. But the fourth revolution comes with opportunities and technologies that are more advanced, more sophisticated but easier for Africa to get into. Electric vehicles are very efficient, far less moving parts, just a motor and battery, none of those complicated parts that could go wrong in a vehicle like pistons, rings, transmission, etc. We believe it's actually easier for African companies and entrepreneurs to get into the electric car market. It's also easier for international companies to adopt such solutions here in Africa. NADDC is committed to electrifying Nigeria and adoption of gas power for vehicles. It's a challenge but we are up to it.

Excerpt from the Pan Africa Network meeting on organised by the CSE on 21 October 2021

Kenya

Kenya was amongst the five EAC countries (along with Burundi, Rwanda, Tanzania and Uganda) to implement low-sulphur fuel (50 ppm diesel fuel and 150 ppm petrol) in January 2015. Low-sulphur fuels reduce vehicles emissions and provide health benefits. Refinery investments were estimated to be US $6 billion in Kenya while the health benefits were as high as US $43 billion.

Sulphur levels in fuels from government owned refineries were found to be as high as 10,000 ppm. In the early 2000s, vehicle assemblers and fuel marketers demanded lower sulphur content. In 2006, the standard was reviewed to 5,000 ppm and refineries were given waiver to produce out of specification. Section 15 sub-section 1 of The East African Community Legislation on Standardization, Quality Assurance, Metrology and Testing (SQMT) Act enacted by the EAC in 2006 states, 'after six months of the declaration of an East Africa Standard (EAS), the partner states shall adopt, without deviation from the approved text of the standard, the EAS as a national standard and withdraw any existing standard with similar scope and purpose.'[50]

The EAC also signed the 2008 EA Regional Framework Agreement on Air Pollution where governments committed to enact regulations to reduce sulphur in imported automotive gas (AGO) to 500 ppm by 2010. Kenya reduced sulphur content as per this EAC commitment via standards that were gazetted and implemented in 2010.[51] The EAC region through the TC for petroleum and petroleum products

harmonized the standard and agreed on timelines to move toward low-sulphur levels. All imported AGO fuel to the region from 01 January 2015 had to comply with the 50 ppm and below requirement.[52] In 2015, the EAC enforced the harmonized EA fuel standards which had been developed following a 2013 EAC legal notice to amend the maximum sulphur content in AGO from 500 ppm to 50 ppm.[53] The Kenya pipeline cannot accept products with higher content.[54]

Due to its port capacity in Mombasa, Kenya is a major conduit for petroleum products to its neighbours. Since 2011, Kenya, along with Tanzania, has been importing 500 ppm fuels, with the Kenya refinery producing in addition on average 7,000 ppm diesel fuel for local consumption. The refinery closed in 2013 and the country was supplied with imported 500 ppm fuel. Refined fuel products come mainly from the Middle East, India and South Africa.[55]

There are plans to further amend the EAS. Discussions are going on to lower the sulphur content in fuels. As 10 ppm sulphur fuel was reported to be imported into the East Africa region in 2018, an agreement was reached in 2019 that the draft EAS will be further revised to 10 ppm sulphur diesel, 50 ppm petrol and introduction of fuel additives such as oxygenates, MMT, MTBE, etc. is to be deferred for the time being.[56]

Kenya can also develop a clean fuel fund to improve fuel quality. This can be done by generating revenue from additional taxes on fuels and cars.

Ethiopia

Formulating emission standards and low-sulphur fuels roadmap: Ethiopia is developing draft emission standards for vehicles which will also address the fuel quality issue. The country has already introduced unleaded petrol. Sulphur content in diesel is still high but it is slowly being lowered. The country imports two types of diesel sulphur fuel—50 ppm and 2000 ppm. At present, the maximum allowable sulphur in diesel and petrol is 500 ppm. Nearly 90 per cent of diesel is imported from the Middle East. Work is in progress and deliberations are going on to reduce the amount of sulphur in fuels.[57]

Quicker introduction of 50 ppm sulphur fuels will enable harmonization. The Ethiopia Petroleum Supply Enterprise (EPSE) will be required to import low-sulphur fuels accordingly. According to EPSE, sulphur content is almost 2000 ppm but 500 ppm sulphur fuel is being imported at present. There are plans to import 50 ppm or 10 ppm sulphur fuels in the coming years. A draft document is

ETHIOPIA – TOWARDS IMPLEMENTING CLEAN FUEL REGULATIONS – CHALLENGES AND PROGRESS

Tadesse Hailemariam, Chief Executive Officer, Ethiopian Petroleum Supply Enterprise

We have to discourage importing used cars. Used cars are major contributors to air pollution. They are also known to be the major reasons for increasing road accidents. They consume a large amount of petrol. We lose huge amount of forex when we import. Frequent requirement of spare parts entails excessive foreign exchange outgo.

We discourage imports through heavy taxes and duties. Since 2019, cars over seven years old are required to pay 500 per cent excise tax and 35 per cent duty rate. Seven-year-old used cars are required to pay 200 per cent excise and 35 per cent duty. Four-years-old cars are required to pay 100 per cent excise and 20 per cent duty. Tax is almost negligible when cars are new. All this discourages importation of used cars.

We are working to encourage domestic assembly of electric powered vehicles. We have incentives for entrepreneurs that include availing land free of lease and easy access to finance. We are encouraging this business. We need a system for scrapping old vehicles. Where shall we dump these cars? Recycling of used cars is needed to recover material. We need to establish automotive research centres to guide this process.

The most important part of this issue is connection with petroleum importation. Ethiopia is net importer of petroleum products. We import mainly from the middle-east. The major products include gasoil or diesel, gasoline or regular petrol, jet fuel/kerosene and light and heavy fuel oils. The lion's share is gasoil which is 65 per cent, followed by gasoline at 18 per cent, jet kero at 15 per cent and fuel oil at 2 per cent. We are discouraging fuel oils. Industries were using furnace fuel earlier, but are now replacing it with electricity.

We have taken initiatives to import low sulphur products. We had been using 5000 ppm gasoil until 2010. We shifted to 2500 ppm in 2011 which extended up to 2016. Since 2017, 500 ppm is in use. But we are planning to move to 50 ppm in 2023. The problem here is that we are using the same terminal at Djibouti port. It gives us common service and that leads to mingling of tanks. For example, a single tank could accommodate Djibouti's portion and ours. But Djibouti is not ready now to go for 50 ppm. We are also working to avoid used cars before going for 50 ppm. At least our vehicles should not be older than 20 years before we go to 50 ppm. In 2023 we are aiming to discard and avoid all cars older than 20 years. In 2024 we in conjunction with our major supplier go for 10 ppm sulphur fuel. Our major supplier for the last 11-12 years has been Kuwait Petroleum Corporation and their refinery will go for only 10 ppm ultra-sulphur products starting from 2024. We will be forced or obliged to have 10 ppm in 2024.

Excerpt from the Pan Africa Network meeting on organized by CSE on 21 October 2021

being prepared to be approved by the government.[58] Ethiopia needs to leapfrog and adopt Euro IV emission standards along with 50 ppm sulphur like other east African countries.

Initiatives have been undertaken to import low-sulphur fuels. The country was using 5000 ppm gasoil until 2010, shifted to 2500 ppm in 2011, and since 2017 has been using 500 ppm. There are plans to move to 50 ppm in 2023. Ethiopia

is also working to avoid used cars before going for 50 ppm. Vehicles should not be older than 20 years when the country goes to 50 ppm. In 2023 it is aiming to discard and avoid all cars older than 20 years and go for 50 ppm. In 2024, the country will attempt to go for 10 ppm due to the major supplier, Kuwait Petroleum Corporation. Their refinery will not produce high sulphur petroleum products and they will go for only 10 ppm ultra-sulphur products starting from 2024. Ethiopia will be forced or obliged to have 10 ppm in 2024.

Zambia

Vehicle emission standard development: Despite the pandemic, Zambia Environmental Management Agency (ZEMA) initiated the development of mobile air emission regulations. Both old and new cars come to Zambia without any regulation. A pilot study was done to understand the vehicle fleet on the ground. After that, deliberations and consultations were done with the legal team and other stakeholders to develop the regulations and standards. Currently, these regulations and standards are being reviewed. The initial draft was validated by some stakeholders. Once the standards are approved, work on the draft regulations will continue. The plan is to start from Euro III and then eventually move to Euro IV. The standards and regulations are to be approved by the Zambian Bureau of Standards (ZABS).

ZEMA has started to procure mobile emission testing machines to be used when conducting a testing programme for large numbers of vehicles in order to validate the emission limits proposed for Zambia, despite starting with Euro II or III. Once the emission limits are validated, then the approval process will be rekindled and concluded by the ZABS which will then feed into the regulations.[59]

Alternative fuel programme in Africa
Is Africa sidestepping dirty mainstream fuels to introduce cleaner fuels?

The challenge of the vehicle market in Africa is the slow change in technology and fuel quality. As a result, the technology of the internal combustion engines running on diesel and gasoline is languishing and it is taking time for the more advanced emissions control systems to attain the scale to make an impact.

While countries are coordinating and strategizing to accelerate technology transition for mainstream internal combustion technology, there is also an opportunity to opt for fuel substitution to curb emissions. One such strategy that has drawn considerable attention is application of compressed natural gas (CNG).

This strategy, as noted in Indian cities, has great potential for reducing emissions substantially.

Some African countries have substantial natural gas reserves. Yet they have very limited alternative fuel programmes even though fuel-substitution strategy is attractive in the developing world to circumvent the poor-quality mainstream fuels. Switching to cleaner fuels in the existing fleet can help lower emissions. There are a few prominent fuel-substitution programmes in Africa including the CNG programme in Nigeria and Egypt. Cote d'Ivoire has joined the list with its CNG buses plying in Abidjan. Ghana is also exploring CNG. The Strategic National Energy Plan 2006–2020 by Energy Commission, Ghana states, 'With the impending availability of natural gas in 2007 and beyond, it is recommended that at least three pilot stations should be installed in Takoradi, Tema and Accra by 2012 and full commercial operations in major coastal cities of Ghana should be possible by 2020'.

Countries developing CNG programmes should address the barriers to laying down of natural gas infrastructure and enable scaling up of the CNG programme in their cities. A comprehensive CNG programme and policy is an opportunity to define the scope and design of the programme to maximize emissions and energy security benefits.

A similar fuel-substitution programme in Asian countries—including India, Bangladesh and Pakistan—has resulted in substantial reductions in emissions. However, such programmes will have to be guided with adequate quality-control and emissions monitoring so that quality retrofits are possible.

Nigeria

Natural gas reserves: Nigeria has an advantage in its access to natural gas reserves. It has already embarked on a CNG programme for vehicles and started targeted conversion of vehicles. While this is a good step forward to strengthen energy security, it is also an opportunity to substitute poor quality mainstream fuels to substantially improve vehicular emissions from current levels. Nigeria has the largest natural gas reserves in Africa. It was the fifth largest exporter of liquefied natural gas (LNG) in the world in 2018.[60]

Pilot programme and its success: CNG use in Nigeria dates back to the late 1980s. The Nigerian Gas Company (NGC) had proposed the use of CNG as vehicular fuel in 1988 and introduced it in 1989. The CNG project began in 2009. A pilot project

was started between the Nigerian National Petroleum Corporation (NNPC) and Nigerian Independent Petroleum Company (NIPCO) through a joint venture, Green Gas Ltd. This drive resulted in significant CNG infrastructure development in and around Benin City. Use of natural gas led to significant savings for taxi drivers. Green Gas refuels over 4,000 taxis and cars. According to the Nigeria Independent Petroleum Company (NIPCO), over 4,000 vehicles have converted to CNG in Benin and over 500 CNG vehicles are also operating in Lagos. The launch of the Clean Energy Transport Scheme involves introduction of CNG-run vehicles and retrofitting of diesel engine to CNG. In Benin City of Edo state, over 50 per cent of taxi operators have converted to CNG. Use of natural gas has translated into significant savings for taxi drivers.

Benefits of CNG: According to UNEP's estimates, if 40 per cent of vehicles in Nigeria switch to CNG, the government can save 28 per cent of foreign exchange spent on the import of 1.02 billion litres of fuel per year. In Abuja, Abuja Investment spends 13.9 billion Naira on automotive gas oil (AGO) per day. The use of CNG vehicles would reduce the cost to 3.6 billion Naira, saving 10.4 billion Naira per day. Similarly, in Lagos, CNG use can reduce the fuel price to 3.8 billion Naira compared to 14.8 billion Naira average per day spent on AGO used by Lagbus and BRT, thereby saving 11 billion Naira. In another commercial hub, Port Harcourt, saving of 5.7 billion Naira per day is possible. The country has already developed an auto gas policy which will ensure the conversion of fuel vehicles to CNG. This is in a bid to improve air quality for a healthy population.

Learning from Delhi programme: Nigeria can also learn and benefit from Delhi, or the India CNG programme. Emissions data from India shows considerable emission benefits from CNG programme, especially if it replaces diesel. At the time of introduction of the CNG programme in Delhi in 2000, both CNG and diesel buses meeting Euro II emissions standards were tested. The test results showed significant improvement. Euro II diesel bus emitted 46 times higher particulate matter compared to Euro II CNG buses. Nigeria should address the current barriers to laying down of natural gas infrastructure and enable scaling up of the CNG programme in its cities.

Future plans and expansion: Natural gas supplies are located at Niger Delta and Lagos. There are plans to expand it to Abuja and Kano. Gas flaring should be stopped to enable utilization of the gas. In addition to the Edo state, CNG infrastructure should be thought of in other states as well. Financial incentives are also important for CNG programme implementation.

CNG transition will be a big step forward in Nigerian cities. The National Action Plan to reduce short-lived climate pollutants (SLCPs) lists adoption of CNG buses in Nigeria as one of the transportation sector measures and proposes conversion of 25 per cent of all buses to CNG by 2030. The government has initiated work on this front. On 01 December 2020, the government launched Natural Gas Expansion Programme (NGEP) for distribution of CNG and LPG across NNPC operated fuelling stations and converted 1 million vehicles to CNG by 2021. Learning from Delhi's CNG programme will be very useful for Nigeria as it plans further and implements the CNG programme.

Federal Government of Nigeria is now embarking on a comprehensive CNG programme and policy. This is an opportunity to define the scope and design of the programme to maximize emissions and energy security benefits. This can comprehensively define the mandate, emissions regulations for CNG vehicles, quality control rules for CNG conversion, establishment of refuelling infrastructure, safety rules and gas pricing policy.

Egypt

Replacing old taxis with CNG taxis in Cairo, Egypt: Greater Cairo with a population of 24 million is the largest metropolitan urban area in Egypt. It consists of three governorates—Cairo, Giza and Qalyubi. Nearly 50 per cent of Egypt's vehicle fleet operates in Greater Cairo.[61]

In 2008, the Egyptian Government passed a new law banning taxis that are over 20 years old from July 2011 and assisted their replacement. The first phase implemented from April 2009 to March 2010 through local banks mobilized by the government succeeded in replacing over 21,272 taxis. Incomes of taxi-owners were expected to increase by 40 per cent while at least 21,250 jobs were to be sustained and 10,500 direct and 1,000 indirect new jobs were to be created for drivers, and staff of vehicle factories and car maintenance and car scrapping companies. The project will also lead to a reduction of up to 0.6 million metric tonne of CO_2 equivalent over a 10-year-period.[62]

Côte d'Ivoire

CNG buses in Abidjan: Côte d'Ivoire is a West African country with Mali and Burkina Faso in the north, Liberia and Guinea in the west, Ghana in the east and Atlantic Ocean in the south. The Ivorian population was estimated at 27 million in 2017. While Yamoussoukro is the political and administrative capital, Abidjan

is the economic capital with almost all institutions based there.[63] The country has planned for natural gas transition in the bus sector.

Natural gas reserves and CNG buses: The country has substantial on-land and off-shore natural gas reserves.[64] On 13 December 2018, Amadou Kone, Minister of Transport, Cote d'Ivoire launched a fleet of 50 Crealis CNG buses in Abidjan. This was as part of the country's commitment to the Paris climate agreement. IVECO, Lyon based bus manufacturer, supplied buses commissioned by the Societe des Transports Abidjanais (SOTRA), public transport company of Abidjan, to ply in Abidjan. The first CNG station set up by the Engie company jointly with Tractebel to fuel the buses is located in SOTRA's premises in Yopougon. This can enable CNG refuelling to four buses at any one time. There are plans to increase the number of CNG buses and CNG infrastructure.[65] Orders for a second lot of 50 Crealis CNG buses from IVECO were placed on 05 July 2019.[66]

Chapter 5: Used vehicle import in Africa

How prepared is Africa to address the special challenge of dumping of old and polluting vehicles?

The problem of the continuous flow of discarded, old, used and cheap vehicles from high-income to low-income countries of Africa and other parts of the world remains neglected in the national and global strategies for air pollution control and climate mitigation. This is leading to an enormous pile-up of clunkers in importing markets that have very little wherewithal to address air pollution, climate and other environmental impacts. Used vehicle import is rampant and a flourishing trade in Africa. African countries are becoming scrap yards for old vehicles from advanced economies. While advanced economies have the capacity to deal with the accompanying problems of vehicles changing several hands within their domestic markets, poorer economies do not.

Low- and middle-income countries that do not have their own vehicle manufacturing base and strong environmental safeguards are most vulnerable to the unregulated and uncontrolled import of used vehicles. But as the pressure is increasing to meet clean air standards as well as the Nationally Determined Contribution (INDC) commitments to reduce pollution and greenhouse gas emissions, developing countries are beginning to frame regulations to reduce vehicular emissions. However, constraints of poorer economies, low level of affordability of consumers, lure of cheap vehicles, lack of clean automotive fuels and weak emissions regulations have created conditions and incentives for the trade of used vehicles and uncontrolled dumping.

Imports to Africa: To understand the overall trade flows and direction of trade, it may be useful to analyse data on the value of international trade reported by the International Trade Centre statistics of the World Trade Organization. This indicates the value of the trade, not the quantum. It also does not distinguish between old and new vehicles. The aggregated value of international trade in vehicles for 2017 shows that vehicles came to Africa from over 17 countries. If total vehicle import is considered, Germany, China and Japan are the biggest exporters to Africa.

Direction of trade changes depending on the vehicle segments as well.[67] The maximum cars come from Germany, Japan, India, Korea and the US. While most of the cars come from the high-income countries, the share of China and India increases in import of commercial vehicles and two-wheelers. Most motorized two-wheelers are from China (62 per cent) and India (26 per cent).

Japan, South Africa and China dominate import of goods vehicles in the region. In the public-transport segment, the highest share is that of Japan at 33 per cent, followed by China at 25 per cent and India at 14 per cent. Public transport vehicles are those that can accommodate over 10 people. Smaller ones are popular largely as para-transit vehicles in the informal sector that meet considerable travel demand.

That vehicle import is hugely dominated by used vehicles is evident from data from the Deloitte Africa Automotive Insights Report, 2016[68] for the major countries of Ethiopia, Kenya and Nigeria. The share of used vehicles is 80–90 per cent of the total imported fleet. In Kenya, the share of commercial vehicles in new sales is the highest at 86 per cent. But in Ethiopia and Nigeria, the share of passenger vehicles in new sales is as much as 84 per cent and 71 per cent respectively.

In low- and middle-income vehicle-importing countries of Africa and South Asia, motorization is riding high on used-vehicle imports. Incentives for old and used vehicles are strong for various reasons. Studies have shown that on average a vehicle's price depreciates faster in a high-income country than in a low-income one. Used vehicles from a high-income country can be sold in low-income countries for higher price, indefinitely extending the lifetime of the imported fleet. Also, it is said that repairs in low-income countries tend to be cheaper because of the lower cost of labour there, holding down maintenance costs overall.[69] Low-income countries also get a wider choice of brands at cheaper prices.[70] Thus, limited number of brands in domestic markets, price differentials and differing depreciation rates incite demand and trade in used vehicles. They also push up average age of vehicles in importing countries. High-income exporting countries with high motorization rates, vehicle stocks and high rate of vehicle replacement have become consistent and large suppliers of old vehicles.

But this trade needs regulation to ensure that very old, gross polluters and damaged and unsafe vehicles do not penetrate these markets. It is argued that with proper regulation, it is possible to source international trade quality vehicles that are better than what is locally produced. But importing countries are often not in a position to take advantage of advanced vehicles from exporting countries as they do not have requisite fuels.

On the other hand, exporting countries that have stronger regulations for vehicle inspection, extended manufacturer responsibility, scrappage and end of-life of vehicles are not vigilant and do not have strong enough regulations for filtering export of used vehicles.

It is important to review the regulatory landscape in both exporting and importing countries as this trade has huge implications for local pollution, health risk and energy security.

Low environmental safeguards enhancing vulnerability: There is a considerable time lag in enforcement of improved emission standards for vehicles and fuel quality across Africa. These standards are not yet uniformly harmonized across the continent—this is blocking emission standards-based vehicle production and import in the region. On-road emissions monitoring is also weak.

UNEP has tracked the evolution in fuel quality and emission standards—it shows wide variance in the current standards across Africa. The constraint of poor fuel quality does not allow immediate harmonization of vehicle emission standards for both vehicle import and local production at the level of Euro IV emissions standards. However, there has been considerable progress in bringing 50 ppm sulphur fuels in South and East Africa that opens up the opportunity to introduce Euro IV emissions standards.

Without the requisite fuel quality, it is not possible to link vehicle import with emission standards. Also, countries cannot take advantage of the newer fleet from the advanced markets as the poor-quality fuel will not allow operation of advanced emission-control systems. This is leading to massive downgrading and stripping of vehicle technology in the region.

Key approaches to regulate vehicle import: Several regulations have evolved in Africa and South Asia that include fixing of age to ensure newer fleet is imported, fiscal measures to make import of vehicles more expensive and discourage very old vehicles, and emission-based taxation to import cleaner and more fuel-efficient vehicles. UNEP has done extensive classification of countries by type of measures they have adopted in Africa (see *Table 7: Vehicle-import regulations in Africa*).

Table 7: Vehicle import regulations in Africa

Banned	Restricted by age		Incremental tax or additional excise duty on age		No import restrictions	No punitive import tariffs	No data
Egypt	Algeria	< 3 years	Kenya	> 3 years	Burkina Faso	Benin	Comoros
Morocco	Angola	< 3 years	Cape Verde	> 4 years	Burundi	Botswana	South Sudan
South Africa	Chad	< 3 years	Sierra Leone	> 4 years	CAR	Burkina Faso	Sao Tome & Principe
Sudan	Mauritius	< 3 years	Ghana	> 5 years	Cote d' Ivoire	Burundi	
	Seychelles	< 3 years	Tunisia	> 5 years	Djibouti	Cameroon	
	Gabon	< 4 years	Uganda	> 5 years	EQ. Guinea	CAR	
	Libya	< 5 years	Zimbabwe	> 5 years	Ethiopia	Chad	
	Mozambique	< 5 years	Tanzania	> 8 years	Gambia	Congo	
	Niger	< 5 years	Cote d' Ivoire	> 10 years	Ghana	Comoros	
	Tunisia	< 5 years	Gambia	> 10 years	Guinea-Bissau	Djibouti	
	Cameroon	< 7 years	Liberia	> 10 years	Madagascar	DRC	
	Congo	< 7 years	Mali	> 10 years	Malawi	Egypt	
	Guinea	< 8 years	Rwanda	> 10 years	Mali	EQ. Guinea	
	Lesotho	< 8 years			Somalia	Gabon	
	Kenya	< 8 years			South Sudan	Guinea	
	Mauritania	< 8 years			Sierra Leone	Libya	
	Namibia	< 8 years			Tanzania	Madagascar	
	Reuniuon	< 8 years			Togo	Malawi	
	Senegal	< 8 years			Zambia	Mauritania	
	Benin	< 10 years				Mozambique	
	DRC	< 10 years				Niger	
	Eritrea	< 10 years				Namibia	
	Liberia	< 12 years				Reunion	
	Nigeria	< 15 years				Senegal	
	Swaziland	< 15 years				Seychelles	
						Somalia	
						South Sudan	
						Swaziland	
						Togo	
						Zambia	

Source: Ariadne Baskin 2018, Africa Used Vehicle Report, Paper presented at the Africa Clean Mobility Week, Nairobi, March 12–16.

Imposing age restriction on imports: Fixing the age of vehicles for import and combining it with tax measures is the most common strategy. In Africa, while four countries, including Egypt, Morocco, South Africa and Sudan, have banned used-vehicle imports, another 25 countries have imposed age restrictions on vehicles. Age restrictions are 3–15 years. Algeria, Angola, Chad, Mauritius and Seychelles have capped the age at three years. Gabon, Libya, Mozambique, Niger and Tunisia have an age cap of five years and less. Lesotho, Kenya, Mauritania, Namibia and Senegal have capped the age at eight years. Benin and the Democratic Republic of the Congo have capped it at ten years, and Liberia, Benin, Nigeria and Swaziland have capped age at 15 years.

Age-based taxation on imports: A large group of countries have linked higher taxes with age of vehicles. The objective of such incremental measures is to discourage import of very old vehicles and promote use and purchase of newer vehicles. This is also combined with vehicle inspection and pre-import inspection programmes. These initiatives in different countries have thrown up different lessons and results.

Country-wise approach to regulate vehicle import: While broad approaches and strategies are common, specific country experiences have thrown up a wide gamut of lessons. These lessons are important as the countries are on their way to further refine their strategies to chart the future roadmap.

Kenya

A combination of age restriction and incremental tax on vehicles has helped increase the overall price of imported vehicles and reduce demand in Kenya. There are serious concerns regarding used-vehicle imports. Nearly 80 to 90 per cent of the vehicle fleet in Kenya is used vehicles. Most of the used vehicles come from Japan and Europe. Officials point out that the older vehicles not only have higher emissions but also have poor safety standards that lead to accidents.

Age restriction on vehicle import: Kenya does not allow import of vehicles older than eight years. This is enforced by the Kenya Customs Department as per the KS 1515:2000 quality standard of the Kenya Bureau of Standards. Kenya also imposes incremental tax based on age of vehicles. A Ministry of Environment official informed that there was no import of used cars by the government.

Import taxes: Overall, five types of taxes are imposed on imported vehicles, including import duty (25 per cent of the CIF of the vehicle), excise duty (20 per

cent of the CIF value plus import duty), VAT (16 per cent of the CIF value plus import duty plus excise duty), Import Declaration Fee or IDF (2.25 per cent of the CIF value or KSh 5000 whichever is highe). CIF is the customs value of the vehicle that includes the cost, insurance and freight paid for the vehicle. The CIF value of the vehicle is also deduced from the current retail selling price (CRSP) of the vehicle.

Age-based taxation scheme: In September 2015, Kenya adopted an age-based taxation scheme for import of second-hand vehicles. Under this law, vehicles less than three years old have to pay 150,000 KSh while vehicles more than three years old have to pay 200,000 KSh. The roll-out of a new tax regime for imported used cars in 2015 caused a massive retail price increase and the price increase resulted in depressing the vehicles market in Kenya. The new taxes, which came into force in December 2015 following the amendment of the excise duty law, increased the prices of smaller vehicles and cut the cost of the luxury ones by up to 1.27 million KSh.[71] According to the Kenya Auto Bazaar Association, the higher taxes will increase the prices of the models by 145,000–364,000 KSh.[72]

Ban on above 1,500 cc 8-year-old vehicles and plan for lowering age limit for import: In January 2019, it was reported that beginning July the age limit for imported used cars will be lowered to 5 years. This was preceded by communication between the Trade Secretary and KEBS in a letter by the former to the latter on 20 December 2018 stating, 'Be advised that government has already committed itself to developing a National Automotive Policy Framework and, at the same time, review the emission levels and age limit on imported used motor vehicles from the current eight years to five years effective July 2019.'[73] On 18 January 2019, the government rolled back the decision to ban importation of 8-year-old 1,500 cc used vehicles till further consultations. However, the ban was applicable on 8-year-old above 1,500 cc used vehicles as per the draft National Automotive Policy directives to be implemented in a systemic manner beginning June 2019.[74] There were plans to reduce the vehicle import age limit further from 5 years to 3 years in 2021 and to all new vehicles in 2023. However, the 8-year age limit is currently applicable.

Ghana

Used-vehicle import far exceeds new-vehicle import in Ghana. In 2015–17, out of the total 336,947 vehicles imported, 221,096 (65.62 per cent) were used vehicles. In 2017, revenue accrued from vehicle import accounted for more than half of the total revenue mobilized by the Customs Division of the Ghana Revenue Authority.[75]

Vehicle import regulations: The Ghana Revenue Authority Customs Division is responsible for imposing import duties/taxes on vehicles in accordance with the revised Harmonized System and Customs Tariff Schedules—2012.[76] The Customs Act 2015 (ACT 891) is the law governing importation of vehicles into Ghana. Sections 55–61 of the Customs Act 2015 (ACT 891) constitutes the principal legislation governing vehicle import. The age of a vehicle imported under the law is calculated from the year the vehicle was manufactured. In June 1998, the government of Ghana had placed a ban on the importation of vehicles over ten years old. Following the amendment of Customs Excise and Preventive Service (CEPS) Act 634 in 2002, the ban was lifted and replaced with the imposition of high import penalty on cars exceeding ten years old. The penalties were further increased in 2015. Penalties are imposed on some category of over-age vehicles in addition to any applicable duties and taxes. Although the purpose of the amendment (penalties on used vehicles importation) was to deter buyers/consumers, it rather gave them an even greater freedom than the total ban on the importation of used cars older than 10 years.

High import taxes on large engine vehicles: Ghana also introduced higher import taxes on vehicles with bigger engines. Tax is higher on cars exceeding 1,900 cc engine category (ranging from 5 per cent, 10 per cent and 20 per cent). They also have an age-based taxation system for imported vehicles. In addition, 0.5 per cent of ECOWAS levy is charged on vehicles. Import duty is dependent on the vehicle fuel type and engine capacity

Problem of salvaged vehicles and smuggling: According to the Ghana Revenue Authority, most vehicles lacked proper documentation as they are smuggled into the country through unapproved routes. Vehicles imported temporarily are mostly not re-exported but fictitiously registered; vehicles in transit to neighbouring countries make a U-turn and end up being registered in the country.[77] People take advantage of the 90-day protocol of ECOWAS—under which imported used vehicles are allowed to operate for 90 days before they are either returned to their country of origin or if they would like to remain in Ghana they have to pay customs

duty but this does not happen. ECOWAS has allowed this to enable interregional transit of vehicles. Media reports that vehicles are deliberately brought from Nigeria, Togo and Benin and not sent back at the end of the three-month ECOWAS Protocol, and Ghana license plates are used illegally.[78]

Officials point out that most of the used vehicles that find their way into Ghana are salvaged vehicles that are accident prone and have less efficient engines. They are often refurbished by the local mechanics to look as good as new vehicles. The influx of these salvaged vehicles causes traffic congestion in cities of Accra, Kumasi and Secondi Takoradi. Apparently, people buy overage or accident-affected cars of the make, model and type that are not more than ten years old and neatly cut off the VIN of car and weld it on the old car so as to avoid overage penalties.

Ban on import of 10-year-old cars: Some reforms have been introduced recently. On 30 April 2020. the President signed a law banning import of cars older than 10 years to be implemented from October onwards. As this law provides import-duty rebates for companies that will manufacture or assemble cars in Ghana, this will boost local manufacturing and assembling. The new law also bans the import of cars involved in accidents, which used to be repaired and sold by dealers.[79]

Ethiopia

As much as 85 per cent of imported vehicles that come largely via the Gulf States, through the Port of Djibouti, are old and used vehicles. Motorization is riding high on these vehicles. Ethiopia has little less than one million vehicles. Nearly 70 per cent of the vehicle fleet is six to over 15 years old. According to the data shared by the Addis Ababa Transport Authority, vehicle numbers have increased by six times since 2002 from a small base level. About 35.6 per cent of cars are more than 10 years old.

Vehicle fleet consists of very old vehicles which have not been maintained adequately. On an average, vehicles being imported in the country are 20 or more years old. The age of most of the national fleet is believed to be 30 or more years. However, most of the public transport buses are new; even trucks are of a newer vintage.

Age restriction: Currently, there is no age limit for vehicles being imported into Ethiopia. The Ethiopian Revenues and Customs Authority (ERCA) worked on new version of tariff tax for imported vehicles. The Ministry of Transport has submitted a proposal to limit the vehicle age to a maximum of eight years to reduce

air pollution and public health impacts. The proposal also aims to ban import of any vehicle and engine whose manufacturers have stopped production.

Fiscal strategy: Even though Ethiopia is among the few countries that have started to assemble new vehicles, imported vehicles outnumber new assembled vehicles. Current tax measures are not designed to provide incentives for newly assembled vehicles over imported vehicles.

The total tax systems have a cumulative effect. The cost of a vehicle till Ethiopia's border is cost plus insurance and freight (CIF). Therefore, the total payment made for import of new vehicles is the sum of five types of taxes: Customs amount (CIF multiplied by customs rate), excise tax (sum of CIF and customs multiplied by the excise rate), VAT amount (sum of CIF, customs and excise tax multiplied by VAT rate), sur tax (sum of CIF, customs amount, excise tax and VAT multiplied by sur tax rate) and withholding tax (CIF multiplied by withholding rate). But in the case of import of used cars, depreciation amount (in years) is deducted, which makes imported used cars cheaper. For example, in the case of a car that is less than or two years old, 10 per cent is deducted from the CIF; if the car is between two and less than three years old, the depreciation amount is 20 per cent; and for cars more than three years old, it is 30 per cent. This clearly shows that depreciation amount increases with vehicle's age and hence shows why Ethiopian importers prefer used cars. The vehicle taxation parameters include vehicle type, manufacturing year, engine capacity, and loading and seating capacity. There is however no tax for local vehicle manufactures. The government collects 40 per cent of the total tax revenue from used cars.

The ERCA's new version of tariff tax has proposed three-level tax rate structure—higher rate for used vehicles, medium for new vehicles, and a lower rate for electric/solar and locally assembled vehicles. There are plans to impose mandatory certificate requirement for imported vehicles.

Vehicle importation is discouraged through heavy taxes and duties. Starting from 2019, cars over seven years are required to pay 500 per cent excise tax and 35 per cent duty rate. Seven-year-old used cars are required to pay 200 per cent excise and 35 per cent duty. Four-year-old cars are required to pay 100 per cent excise and 20 per cent duty. Tax is almost negligible when cars are new.

Nigeria

The challenge of used-vehicle import: Till 2013, Nigeria had about 5.7 million registered vehicles and was fourth in Africa, after South Africa, Algeria and Egypt. One-third of the country's vehicles are concentrated in Lagos state alone. A 2016 report by PricewaterhouseCoopers Limited (PwC), called Africa's Next Automotive Hub, shows that only 11 per cent of second-hand cars are equal to or less than five years old; 26 per cent are in the age bracket of 6–11 years; 50 per cent are in the 12–18 years age bracket; and 13 per cent are over 19 years. Thus, 89 per cent of all the cars are over five years old.

Used-vehicle import is also pushing the market towards larger and older vehicles that guzzle more fuel. Vehicle segment-wise analysis of used vehicles data by PwC shows 35 per cent are large cars, 24 per cent SUVs, 22 per cent small cars and the remaining are pickup and commercial vehicles. Even though the majority of cars come from the US, Japanese cars dominate.

The large number of old and used vehicles have aggravated the problem of pollution and road safety in cities of Nigeria. In fact, as per the records of the Federal Road Safety Corps (FRSC), these old vehicles represent 80 per cent of the vehicles involved in road traffic crashes. Many of them are with faults that caused them to be recalled in their countries of origin. This requires serious attention as Nigeria is motorizing steadily.

Nigeria is an important example in Africa that, though swamped with imported old vehicles, is gearing up to control this flow effectively to build its own industry. In 2012, as per the records of the Nigerian Customs Service, over 75 per cent of its vehicles were imported used vehicles. This influx had led to shutting down of 75 per cent of car and truck assembly plants in the country. Increasing manufacturing costs and customer demand for cheaper and varied brands were responsible.

Growing demand for imported vehicles in the populous country can have destabilizing effects on their balance of payments. This needs to be offset by setting up vehicle-manufacturing facilities. Nigeria had started to promote local assembly during the 1970s and 1980s, when the Federal government set up state-owned plants across the country. It drew up agreements with European carmakers such as Peugeot Nigeria Ltd, Styer Nigeria Ltd and National Truck Manufacturers, Volkswagen of Nigeria, Leyland Nigeria Ltd, etc. But, during 1990 and 2013, this process declined, coinciding with growing oil imports. This led to the government divesting its interest in several companies, undermining local assembly. There is a

new policy now to revive the local car industry. A PwC study in 2016 has projected that Nigeria will generate 6 million new cars by 2050, when consumer preference for new cars will increase and, as a result, demand for importing used cars will decline—from 70 per cent of import currently to 35 per cent in 2028 and to zero by 2034. Used cars, or Tokundo, will however continue to dominate until 2025.

Step towards local manufacturing: The government of Nigeria is now adopting strategies to build local assembly units. The government has approved the New Automotive Industry Development Plan to curtail total dependence on import. The three existing auto clusters in Nigeria are Lagos-Ogun-Oyo, Kaduna-Kano and Enugu-Anambra. Nigeria has also set up state-of-the-art vehicle test centres with the help of the Automotive Research Association of India (ARAI), where automotive products can be tested to conform with standards and vehicle homologation. The NADDC is collaborating with the SON to develop 200 vehicle safety and component standards which align with ISO quality certification. It is also setting up auxiliary industries. They are also revamping the vehicle roadworthiness inspection system.

Tightening of tax measures for vehicle import: A key strategy to support this initiative is adopting tougher policies on vehicle import. The Nigerian government is increasing the cost of import. Fiscal policy is being designed so that it helps create an environment in which existing assembly plants survive and grow, and incentivizes incorporation of local components. Fiscal measures, which include a sliding scale of tariffs and levies, came into effect in July 2014 for import substitution. The NADP sets the tariff at a maximum of 70 per cent (35 per cent duty plus 35 per cent levy) for fully built-up cars and 35 per cent duty without levy for commercial vehicles. This level is expected to decrease only after the sector grows competitive. Completely knocked down parts (CKD) and semi-knocked down parts (SKD) for assembling will be charged 0 per cent, and 5–10 per cent duty (see *Table 8: Progressive change in import tariff, 2014–15 to 2017–18*). Previously, importers and car dealers paid 20 per cent duty along with a 2 per cent levy on cars. As much as 70 per cent tariff on fully built imported vehicles has been implemented in January 2015. Vehicle purchase credit is also being promoted to encourage purchase of locally assembled new vehicles.

Table 8: Progressive change in import tariff, 2014–15 to 2017–18

Year	Objective	Incentive
2014–15	Allow existing assembly plants to survive and attract other OEMS	i) Cars: Levy of 35 per cent charged on car fully built units (FBU) in addition to 35 per cent duty ii) Commercial vehicles: 35 per cent duty without levy iii) Tariff on CKD, SKD 1 and SKD 2: 0 per cent, 5 per cent and 10 per cent for local assembly plants iv) Assembly plants to import FBU at 35 per cent and 20 per cent duty without levy for cars and commercial vehicles respectively in numbers equal to twice their imported CKD/SKD kits
2019–24	Institute incentives for local content incorporation	i) Levy on car FBU reduced to 20 per cent. Tariff remains at 35 per cent ii) Duty on commercial vehicle FBU remains at 35 per cent without levy iii) Tariff on CKD, SKD 1 and SKD 2 remain at 0 per cent, 5 per cent and 10 per cent respectively iv) Concessionary FBU import by APs to be up to half of their imported CKD/SKD kits
2016–18	Allow existing assembly plants to grow and attract more OEMs and local content suppliers	i) Levy on car FBU reduced to 20 per cent. Tariff remains at 35 per cent ii) Duty on commercial vehicle FBU remains at 35 per cent without levy iii) Tariff on CKD, SKD 1 and SKD 2 remain at 0 per cent, 5 per cent and 10 per cent respectively iv) Concessionary FBU import by APs to be up to half of their imported CKD/SKD kits v) Concessionary FBU import by APs to be equal to their imported CKD/SKD kits

Source: NADDC

Fiscal measures impact vehicle imports: During the last three years, vehicles imported from Europe, Asia and the US have reduced by 81.25 per cent or the equivalent of Nigerian naira (NGN) 490.5 billion. According to Nigerian Ports Authority (NPA) data, the country imported 73,000 vehicles worth NGN 109.5 billion (or 18.25 per cent of the 400,000 units it previously imported) in 2017. Imports are expected to reduce further as only eight vessels were laden with 3,210 units of used vehicles in January 2018. While Nigeria imported more than 100,000 cars per year from the US, imports from the US in 2015 declined to less than 40,000 units. Toyota Nigeria's share of imports dropped to 38 per cent in 2016 (from 43 per cent in 2015). According to Toyota Nigeria in Lagos, forex and high interest rates were also challenges of bringing vehicles into the country. Car imports dropped by about 60 per cent between 2015 and 2016.

High import duty on vehicles might have reduced import of used vehicles, but there are concerns around vehicles being smuggled from neighbouring countries such as Benin, which impose low import tariff. Since 1 July 2017, Benin has reduced the amount charged for vehicles in transit. Thus, the price to clear a car discharged in Cotonou in transit to Nigeria has been slashed from CFA 3,99,920 (Naira 257,000) to CFA 2,90,000 (Naira 186,000). In order to mitigate the risk of smuggling, the customs authorities from Benin and Nigeria have intensified efforts to collaborate and work towards full compliance with the ECOWAS trade agreements.

The Nigeria Customs Service (NCS) plans to introduce a uniform value on vehicles imported into the country to curb diversion to neighbouring ports and under-declaration at various ports and borders. NCS needs to publish the price of new vehicles annually and provide a transparent benchmark to determine the value of used vehicles.

In 2017, the National Automobile Design and Development Council (NADDC), however, said it would not ban the import of used vehicles. The ban would only take full effect when a robust vehicle finance scheme (to be launched by 2018 end) was available to enable citizens to buy brand new vehicles. The NADDC plans to work closely with other stakeholders to address the sector's challenges and promote initiatives that would enable it to produce affordable vehicles that would ease the country's mass transport challenges. The NADDC is working on a plan with the SON to introduce compulsory issuance of roadworthy certificates on all used vehicles to be imported into Nigeria from their countries of origin.

Other measures: The government has formed the National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2011. This has led to a ban on import of two-stroke engines, prohibition of motor vehicles without approved emission reduction technology, penalty for violators and annual testing of vehicles for toxic gas emissions. The government has approved the National Vehicular Emission Control Programme (NVECP) to be run on a public private partnership model, which involves establishment of vehicle-emission testing centres nationwide, annual testing of vehicles for emissions and collection of data.

Uganda

There are over 1.5 million vehicles in Uganda of which nearly 30 per cent are motorcycles.[80] Over 85–95 per cent of these are used vehicles from Japan and Europe and are more than 10 years old.[81] Uganda does not have major vehicle assembling plants, only small ones.

Uganda has made four strategic interventions to improve its vehicle fleet—imposition of environment levy on used vehicles and higher taxes on bigger engines; vehicle-emission inspection; vehicle-age restriction; and pre-shipment inspection.

Environment levy and higher taxes on older engines: The environment levy is designed to discourage importation of very old vehicles. It was started in 2010 and has been progressively revised. Used vehicles aged between 5 to 10 years and above 10 years are required to pay 35 per cent and 50 per cent of cost, insurance and freight (CIF) value respectively as environmental levy. Goods vehicles (3.5 tonne and above) are exempt. The environment levy favours import of less than five-year-old vehicles. Goods vehicles are excluded from the environment levy mainly because Uganda is a landlocked country without sea link and is heavily dependent on roadways.

Environment levy seems to have made some impact. In 2014–15, out of 51,629 imported vehicles, more than half (35,901) were used vehicles. But in 2015–16, the number of used vehicles came down to 18,922.[82]

According to officials, the policy to reduce importation of old vehicles is fiscal and may not necessarily achieve the objective of reducing importation of used vehicles over time. The policy is more of a tax policy to increase revenue to finance all government programmes. Reduction in number of old vehicles imported and purchased by consumers do not necessarily lead to any significant corresponding increase in purchase of new vehicles. Affordable price of older vehicles remains a strong incentive.[83]

Officials observe that even if 50–100 per cent levy is imposed, an old vehicle remains cheaper than a new one. For instance, while used cars cost USh 10–20 million, a new car would be around USh 65 million.[84] New vehicles are still too expensive for most Ugandans to afford.[85]

Vehicle age: Uganda is also considering age restriction for vehicle import. The Traffic and Road Safety Act 1998 (Amendment) Bill 2018 proposes an eight-year age restriction from the date of manufacture and revision of environment levy. There was a discussion in parliament to lower the age to eight years. Vehicle importers, transport associations and the general public protested. So, a compromised position of graduated reduction was expected. The Parliament has now fixed 15-year age cap for vehicle import.

Vehicle emission inspection: Uganda has re-established mandatory vehicle inspection. Based on the NEMA/Uganda National BS guidelines, roadworthiness tests and emission standards enforcement are carried out. All vehicles come for inspection. At present, emission results are not used to fail or pass a vehicle as almost all vehicles are likely to fail. The purpose is to gather data to inform further policy decisions on vehicles, including vehicle age, fuel standard, maintenance procedure regimes, etc. The regulation is yet to be enforced.

Pre-shipment inspection: The additional step is to introduce pre-Export Verification of Conformity (PVoC). The new pre-import standard US845 specifies safety and performance characteristics of vehicles and their inspection and testing for roadworthiness. The PVoC requires exporters to apply for assessment of their exports for conformity with the new standard. A certificate of conformity (CoC) is issued to the exporters on passing the test and is valid for a year to be followed by another roadworthiness test.[86] Three firms are currently engaged for pre-shipment inspection of vehicles. Inspection is done in the country of origin as per the given manual of the Uganda standards, EAC standards, and international safety standards. A certificate of conformity and a certificate of roadworthiness and radiation levels is issued. Defaulters are fined 15 per cent of the CIF value.[87]

The problem of used-car import is increasingly drawing political attention in the country. Uganda's Environment Minister Frank Tumwebaze was quoted in the media stating, 'The vehicles imported are largely old used vehicles with an average age of 16 years and instead of crushing them in Japan they say let us send them to countries like Uganda.'[88]

The learning from Uganda is that import taxes need to be designed more effectively in combination with age restrictions to make a difference. Otherwise, the tax measure will only degenerate to a revenue-generating strategy. Tax measures on their own cannot make new vehicles competitive. It is important to eliminate the old stream through regulations.

Mauritius

Mauritius has adopted diverse strategies to regulate vehicle import, including age limit, and emissions-based and engine size-based taxation. It has also adopted regulatory mechanisms for oversight and accountability that offer a rich learning curve.

Age cap and number controls: Mauritius has imposed age limit on all imported used vehicles. While used imported cars, SUVs and jeeps are required to be between 18 months and four years old, age limit for double cabs, 2 x 4 or 4 x 4, is between 18 months and three years. The age of goods vehicles cannot exceed six years; vans carrying goods and up to seven passengers cannot exceed four years, buses three years and motorcycles one year without any permission for resale. The reason for minimum age limit of 18 months is mainly to protect the new car industry.

There is also quantitative control on imports of used vehicles. In case of cars, an individual is allowed one car every five years. A taxi owner is allowed one car every four years. There is no restriction on an authorized dealer. Motorcycles have a total import restriction for resale—only one motorcycle of less than a year as a gift or resettlement is allowed. For vans, buses, lorries and trucks, one vehicle every five years for each vehicle category is allowed. This helps control the total volume of vehicles in this land-constrained country.

CO_2 levy/rebate system: CO_2 levy/rebate system was introduced in July 2011 to reflect the polluter pays principle in vehicle taxation. The Excise Act was amended in July 2011. The CO_2 threshold adopted for the purpose of taxation was 158 g/km. This was derived from the average emission values of all new vehicles sold during the previous year based on the data obtained from importers. If the CO_2 emission of a vehicle was below 158 g/km, it was eligible for rebate and, if above, it had to pay a levy on the excise duty payable for that vehicle.

This scheme was applied to both new and used cars, jeeps and SUVs. The CO_2 emission standard used initially was the United Nations Economic Commission for Europe Regulations 101 (UN-ECE Regulations no. 101) but as there was the problem of comparing standards for vehicles not tested as per European standards, the legislation was amended in 2013 to provide for other standards to be used for vehicles imported from other countries, including Japan, India and Korea.

The rebates were awarded in two categories. Vehicles with CO_2 emissions up to 90 g/km were awarded a rebate of Mauritian Rs (MUR) 3,000 per gram for standard

UN-ECE Regulation no. 101 and a lesser amount of MUR 1,000 per gram for other standards. For vehicles complying with 91–150 g/km CO_2 emissions, rebate of MUR 1,000 per gram for standard UN-ECE Regulation no. 101 and MUR 350 per gram for other standards was awarded. Vehicles which did not comply with CO_2 threshold were penalized and a levy was imposed.

Unintended consequence of CO_2 levy/rebate system—increase in import of used cars: This scheme was expected to be revenue neutral, i.e., the amount of levy collected had to more or less compensate for the amount of rebate paid. But financial analysis showed the opposite—the rebate amount had consistently exceeded the levy amount and this was highest in 2013.

Corrective measures 2013: This led to corrective measures being taken in November 2013 that lowered the CO_2 threshold further from 158 to 150 g/km. In addition, for vehicles complying with UN-ECE Regulations no. 101, rebates were lowered from MUR 3,000 per gram to MUR 1,000 up to 90 g/km and from MUR 1,000 to MUR 350 per gram for levels within 91–150 g/km, i.e., the same rates as those applicable for second-hand vehicles.

It again emerged from the 2015 data of Mauritius Revenue Authority (MRA) Customs that while the scheme was revenue neutral for new cars under UN-ECE standard, there was a financial deficit for used cars meeting other standards. Used cars that got a lower rebate were still benefiting more from the rebate scheme (257 million Mauritian rupees more) than new cars under UNECE (1 million Mauritian rupees). It was found later that because of dubious certification and false claims, used cars could show lower limits to corner the benefit of the rebate. This worked against new vehicles. It was clear that the CO_2 rebate/levy system was favouring used cars over new cars.

In 2013 and 2015, when there was a dip in the sale of new vehicle numbers, sale of second-hand vehicles increased.[89] There was sharp reaction from new-car dealers. Since the introduction of the CO_2 levy/rebate system, the sale of used vehicles increased significantly. Sale of used vehicles peaked in 2015 with a sharp decline in sale of new vehicles. There were representations from new car dealers to the MOFED with data indicating clearly that the scheme was promoting used cars over the more environmentally friendly new cars.

The reversal—introduction of excise duty restructure linked with engine size: A committee was formed to look into the scheme for revenue neutrality and whether the threshold should be lowered further and also to look into the merit

of abolishing the CO_2 rebate while keeping the CO_2 levy as was the case in South Africa and the UK. It was found that on the basis of dubious certification, used cars could show lower emission limits to get the benefit of the rebate.

It was also found that different standards for CO_2 emissions were used for the purpose of taxation and there was no formal arithmetical equivalence to compare those standards, and unreliable CO_2 values were used for computation of the levy or rebate.

The Budget of July 2016 led to the suspension of the CO_2 based scheme due to operational and litigation glitches, which hindered its proper functioning. This suspension will remain valid until harmonized CO_2 measurement becomes effective under the World Harmonized Light Vehicles Test Procedure.

After the suspension of the CO_2 levy/rebate scheme, the government restructured the excise duty based on engine capacity to control fuel guzzling. The new rates give advantage to smaller engines. Cars up to 550 cc were exempt from excise tax. For cars of engine capacity 551–1,000 cc and 1,001–1,600 cc, excise duty has been reduced from 55 per cent to 45 per cent and 50 per cent respectively. However, for cars of 1,601–2,000 cc and above 2,000 cc, the excise duty remains unchanged at 75 per cent and 100 per cent respectively. Excise duty therefore is related to the engine capacity of cars and is higher for bigger cars. Thus, engine size became a proxy for CO_2 emissions. After 2016, new vehicles registration gained momentum with decline in second-hand vehicles

Fiscal measures to promote hybrid/electric cars: The 2016–17 Budget announced excise duty favouring cleaner vehicles and significant lowering of excise duty for cars with low engine capacity and hybrid and electric cars. The share of hybrid and electric cars increased from 4 per cent in 2015 to 12.9 per cent in April 2017.

Other fiscal measures promoting cleaner vehicles: While new and imported used cars (first entry in Mauritius) have to pay the same registration duty depending on the engine capacity ranging from MUR 3,300 to 1,95,000 (depreciating rate on subsequent transfer of vehicles in the local market), the registration duty for hybrid cars was 50 per cent of the normal rate depending on the engine capacity and age (depreciating rate on subsequent transfer of vehicles in the local market) and for electric cars from 25.5 kW up to 180 kW ranged from MUR 8,100 to MUR 39,000 and MUR 97,500 for electric cars more than 180 kW.

The registration duty has been reduced for electric cars with engine power up to 180 kW and fewer thresholds/bands of engine power (13 bands of engine power revised to only six bands). To promote hybrid cars, excise duty was lowered on all engine categories from 55 to 25 per cent for up to 1,600 cc hybrid cars, from 75 to 45 per cent for 1,601–2,000 cc cars and from 100 per cent to 70 per cent for above 2,000 cc hybrid cars. The government has exempted all electric cars up to 180 kW of excise duty (it was 25 per cent earlier) and there is no change (25 per cent) for electric cars above 180 kW.[90]

The structure of the road tax also favours vehicles of low engine capacity as well as hybrid and electric vehicles.

Setting systems for verification for imported vehicles: Mauritius has set up an elaborate system for checks and verification that presents a good learning curve in the region. For second-hand vehicle import, a series of documents are required—including import permit; inspection certificate from a competent authority to certify that the vehicle has been inspected not earlier than two months prior to shipment, the vehicle is not stolen, roadworthiness and usability of the vehicle and the auction grade if the vehicle is imported from Japan; a document from the exporting country certifying that the vehicle is not stolen; a deregistration certificate and an export certificate issued by the official registration body; and a certified copy of the original auction sheet for second-hand vehicles from Japan to protect consumers.

Obligation of vehicle dealers and accountability: Mauritius has also detailed the legal obligation of car dealers that helps improve accountability. Authorized dealers need to be registered and licensed with the Ministry of Industry, Commerce and Consumer Protection, own a showroom for display of cars, provide the Ministry with a bank guarantee or security for an amount of MUR 2.5 million (approx. US $75,000), allow purchasers to test drive vehicles, provide vehicle inspection certificate to purchasers, hold spare parts and repair facilities for vehicles imported and sold, enter into a sale agreement with the purchaser setting a warranty period for the car sold and submit to the relevant Ministry a certified copy of the sale agreement within three days showing that the agreement has been executed. It's up to the authorized dealer to effect all the repairs free of charge and provide any purchaser a vehicle in a good roadworthiness state, otherwise the Ministry has the power to compensate the purchaser from the bank guarantee.

A lot of attention has been given to extending consumer protection from import of damaged vehicles. This became necessary when, after the tsunami in Japan,

many cars affected by flooding were recovered, washed, drained and exported. To counter such problems, warranties are asked for from the competent certification authorities in exporting countries. They have to give a guarantee of US $1,00,000 to state that the certificate issued is a genuine and credible one.[91]

Mauritius throws up important lessons. It has simultaneously imposed age caps, restraints on frequency of vehicle purchase, and emissions-based taxation that was subsequently replaced by engine size-based excise tax. Yet, among these progressive measures, emissions-based taxation faced barriers. It led to unintended consequences of pushing up sale of older and used vehicles even though the rebates were lower for these vehicles compared to newer vehicles. First of all, there was the technical and administrative challenge of enforcing emissions-based taxation as the emissions standards of different countries of origin were not directly comparable. Imposition of emissions-based taxation requires globally harmonized systems to enable comparability of emissions standards in exporting countries. It is not often within the management capability of importing countries such as Europe and Japan to establish technically sophisticated systems to govern such imports. Documentation to enable implementation of such systems is also extremely complex. This led to enormous leakages, especially while importing used vehicles, as dubious certificates made false claims of fuel economy or CO_2 emissions. This increased sales of used vehicles, leading to a huge fiscal deficit, instead of keeping the programme revenue neutral. Also, the subsequent engine size-based regulations have been found to be more transparent, viable and easily enforceable within the current administrative capacity.

In the future, with global harmonization of regulations, it might still be possible to revert to CO_2- or fuel economy-based regulations. But this requires a word of caution. Only CO_2-based regulations without commensurate improvement in emissions standards for vehicles may lead to market distortion in favour of diesel cars. Mauritius could avoid such a pitfall as the price gap between petrol and diesel fuels is very narrow, taxes on bigger engines are much higher and consumer preference is in favour of petrol cars. But this may not be the case in other countries.

Yet another lesson from Mauritius is its effort to set up elaborate institutional processes to establish accountability of the car dealers and a verification process to ensure roadworthy vehicle imports.

Rwanda

In Rwanda, excluding motorcycles, 56.7 per cent of all vehicles are pre-1999 and 77.2 per cent are pre-2005.

Fiscal strategy: There is no age restriction on imported vehicles. In order to discourage old vehicles, car depreciation factor is applied on taxes. Rwanda implemented the East African Community (EAC) depreciation schedule through a free-on-board depreciation rate ranging from 20 per cent for two-year-old cars, 75 per cent for nine-year-old cars and 80 per cent for cars ten years old or more.

This strategy has helped make older cars more expensive. This, for instance, has resulted in doubling of the price of most preferred Toyota cars. The Rwanda Revenue Authority noted a drop in car import by around 20 per cent after introduction of this system. New vehicles with engine capacity less than 1,500 cc pay a 5 per cent tax; vehicles with engine capacity between 1,500 cc and 2,500 cc capacity pay 10 per cent, and those with over 2,500 cc engine capacity pay 15 per cent. Despite the heavy tax burden slapped on used cars, demand is still high.

It is clear that taxes will have to be progressively revised to moderate the demand. Fiscal measures will have to be backed by age restrictions. Rwanda needs to consider more stringent measures to control used-vehicle import as it is also planning to set up its local assembly of vehicles. It is reported that companies like Volkswagen have plans to set up a local assembly plant.

Zimbabwe

Zimbabwe's vehicular fleet size in 2016 was 1.2 million. Vehicles are imported largely from Japan, Europe and UK. During 2000–17, Zimbabwe reduced imports that resulted in a shift to imports of second-hand vehicles at the expense of the local assemblers and local component manufacturers. Affordable price is the reason for influx of second-hand vehicles. While the price of importing a second-hand vehicle is in the range of US $3,000–7000, the price of a new vehicle of the same make is in the range of US $10,000–20,000. The new-vehicle market has shrunk from 20,000 vehicles per year in 1997 to less than 3,154 in 2017. Thus, local manufacturing is nearly decimated.

Age restriction: In 2011, a ban on vehicles over five years old was considered in view of safety and environmental considerations, but this could not be implemented due to public pressure.

Fiscal strategy: The charges levied on vehicle imports include customs duty, surtax and VAT. Vehicles with large engine capacities have to pay high customs duty—86 per cent customs duty for vehicle of less than 1,500 cc capacity and 96 per cent for those exceeding 1,500 cc capacity. Other measures include appointment of international certification agency Bureau Veritas to conduct the Consignment Based Conformity Assessment (CBCA) in order to reduce hazardous and substandard imported products and improve customs duty collection. Bureau Veritas has been appointed by the Ministry of Industry and Commerce of Zimbabwe for the verification and assessment of conformity of goods in exporting countries. Since 27 July 2015, all imported products (including automotive and transportation and others) regulated by the Ministry of Industry and Commerce must be accompanied by a CBCA certificate.

Promoting local industry: The Zimbabwe Motor Industry Development Policy (ZMIDP) aims to encourage both local and foreign direct investment in the local automotive assembly and components manufacturing to 10 per cent of total foreign direct investment by 2026 and exports to 50 per cent of total local production by 2026. It seeks to increase capacity utilization of car assemblers from the current levels which is less than 10 per cent to 100 per cent of installed capacity by 2026. ZMIDP is also looking at getting banks to offer credit terms to buyers for locally made new vehicles.

Côte d'Ivoire

During 2010–17, Côte d'Ivoire registered 0.45 million vehicles. As much as 89 per cent of these were used vehicles. Age-wise vehicle import data of 2010–17 shows that 31 per cent of vehicles are in the age group of zero to five years, followed by 14 per cent in the age bracket of six to ten tears. But 55 per cent are over ten years old. This is threatening the air quality of its city of Abidjan.

Age restriction: On 6 December 2017, Côte d'Ivoire adopted two decrees—Decree No. 2017-792 limiting the age of imported second-hand vehicles and Decree No. 2017-793 fixing the operating periods of vehicles used for public or private transport of persons or goods. The two decrees limit the age of imported used vehicles to five years from the date of registration. This also specifies the average operating period of vehicles at seven years from the first date of entry into circulation. This came into effect from July 2018. Age limit for commercial vehicle segments are—taxis (five years), mini buses with nine to 34 seats (seven years), trucks and buses (ten years), and tourist vehicles (five years). Earlier, the average age of imported used vehicles was about fifteen years.

Fiscal strategy: In Côte d'Ivoire, import of vehicles is governed by a law that imposes a contributory fee (US $300) on road safety, congestion and pollution from vehicles. This contributory fee is imposed on ten-year-old passenger and freight vehicles with total permissible gross weight less than or equal to 4 tonne and 15 years for goods vehicles with a gross vehicle weight of more than 4 tonne.[92] Vehicles over ten years old are also charged extra duty.[93]

Vehicle inspection: There is an obligation on vehicles traveling in Côte d'Ivoire to undergo a technical inspection to guarantee the safety status of goods and people. This is a pre-importation inspection for road worthiness.

Côte d'Ivoire is a unique example in which the government has linked an additional fee on import of old vehicles to the guiding principles of road safety, congestion and pollution. These operative principles have helped impose stronger tax measures to curtail import of very old vehicles. Yet another important progressive step is the government's decision in 2012 to keep the price of diesel and petrol the same. It is also recognized that diesel vehicles are more polluting.

Tanzania

According to 2016 registration data, Tanzania has a registered vehicular fleet of about 0.3 million excluding motorcycles and tricycles. Of these, only 4.5 per cent are new vehicles. About 12.4 per cent vehicles are one to eight years old and 83 per cent vehicles are over eight years old.

Age restriction: Tanzania has not enforced age restrictions yet.

Fiscal strategy: Tanzania has adopted the policy of additional excise duty that increases with age of vehicles. For instance, vehicles aged eight to ten years pay 15 per cent additional excise duty; those over 10 years pay 30 per cent; and used imported buses over five years old pay 10 per cent. This is also backed by the two-slab taxation based on engine size. Vehicles up to 1000 cc do not pay excise duty. But, thereafter, vehicles with engine capacity below 2,000 cc pay 5 per cent and those exceeding 2,000 cc pay 10 per cent. Vehicle registrations show a marked decline after 2014 in Tanzania.[94]

Tanzania is another country that has adopted fiscal measures without age restrictions. It seems to have had some impacts on import. To maximize impacts, combining age restrictions with harsher fiscal measures will help. Otherwise, as

seen in other countries, very cheap old vehicles will always undercut the market for new and cleaner vehicles.

Mozambique

Age restriction: The government is finding it increasingly difficult to impose restrictive policies on used-vehicle import as this draws public opposition. In the absence of adequate public transport policy, dependence on small vehicles and cars is enormous. A law was introduced in 2007 to discourage old and used vehicle import but there was public opposition. Officials feel that in the absence of public transport, it is not possible to prohibit importation of vehicles, even used vehicles, which even with an extra tax are cheaper than new vehicles.

Fiscal strategy: Mozambique adopted single-window clearance for customs and importation of goods in 2011. The tax on used vehicles varies from 5 per cent to 20 per cent. There is no age limit on vehicles but an extra tax is imposed from seven years onwards to discourage importation of used vehicles. They have a stratified tax system based on engine size. Bigger engines attract higher taxes.

Like other countries, Mozambique is facing the dilemma of public aspiration that blocks action on very old and cheap cars. It is, however, important that the government has recognized the link between the lack of public transport and increased dependence on old and cheap cars for personal travel and therefore public opposition to harsh measures against used vehicle import. In fact, the government is encouraging import of three-wheelers from India and China to increase public-transport service. An affordable train service has been introduced for workers this year.

Zambia

In Zambia, Road Traffic Act no. 11 of 2002 provides for two types of registration processes—temporary for vehicles imported and manufactured in Zambia, and permanent registration for all vehicles in Zambia. Zambia currently has no vehicle-manufacturing plant. So, all vehicles registered are imported either brand new or used. Zambia had a total vehicle population of around 748,468 (public and private) in 2018 first quarter. This excludes the vehicles for government and intelligence wings. About 85 per cent of these registered vehicles were imported used vehicles. Vehicles are brought into the country either by individuals or motor-vehicle dealers. Vehicle and trailer registration requires recording of details in the national vehicle register.

Vehicle import is regulated by organizations such as the Zambia Bureau of Standards (ZABS), which regulates the roadworthiness of vehicles before shipment by appointed agencies, for example JEVIC, Zambia Revenue Authority (ZRA) for taxation purposes, INTERPOL for clearance of vehicle for lawful entry, Road Transport and Safety Agency (RTSA) for examination, registration and licensing of vehicles and Zambia Environmental Management Agency (ZEMA) for environmental pollution (carbon emissions surtax).

The import requirements vary for new and used vehicles. For new vehicles, invoice, road manifest or bill of lading as the case may be, and export bill of entry from the country of export are required. The valuation of new vehicles is based on the World Trade Organization Agreement valuation method and duties and taxes are applied on an ad valorem basis. New vehicles have to pay import duty; import VAT, excise duty and vehicle registration fee.

In the case of used vehicles, in addition to invoice, road manifest or bill of lading as the case may be, export bill of entry from the country of export, JEVIC Inspection Certificate required by the Zambia Bureau of Standards and Interpol Clearance are also required. The duties and taxes on used vehicles are specific and based on the age and type of vehicles. The tax amounts are legislated and therefore known to the importer and customs broker. In addition, vehicle registration fee and carbon emissions surtax are also payable.

Demand for used vehicles is high because of limited disposable income and lack of vehicle-assembly plants. Cheaper used vehicles allow households/businesses to own vehicles. Currently, older vehicles attract higher duties and taxes. The feeling is that short-term policy options need to be micro-finance facilities to enable public and private entities to procure new vehicles, strengthening pre-shipment roadworthiness assessments. This requires changes in the current import duty and excise tax treatment for imported vehicles. This should be further supported by age cap on imported vehicles. The medium- to long-term policy options are strengthening of public transport system, introduction of non-motorized transport system and incentives for establishment of vehicle-assembly plant. Therefore, implementation of clean vehicle importation policy is important for cleaner environment and improved road safety. This will require clarity, efficiency and transparency, and reduce corruption in vehicle importation.

The experience of Zambia brings out the importance of linking tax measures with age caps. Currently they have imposed higher taxes on older vehicles which is a right principle. But without a robust monitoring system and proper documentation, the

system can be compromised by under-reporting age of vehicles. Enforcement is a challenge. Moreover, as the officials point out, it is also important to come up with fiscal incentive structures to encourage people to buy newer vehicles that are more expensive.

Swaziland

Fiscal measures: Swaziland has imposed a three and six per cent levy on used non-Southern African Customs Union (SACU) vehicles imported from Dubai and those subsequently shipped elsewhere in the Middle East and Asia.

This levy was imposed on all vehicle import from outside the region in terms of Legal notice number 35 of 2018. Three per cent levy of the total value will be imposed on six- to ten-year-old vehicles and a six per cent levy on 11–15-year-old vehicles. According to vehicle dealers, the levy will increase the vehicle prices and lead to a drastic decline in Dubai-vehicle sales as buyers will prefer SACU-produced vehicles.[95]

VOICE FROM SOUTH ASIA

Lesson from South Asia—How Sri Lanka has transformed vehicle market with fiscal and import policies to promote clean vehicles and electric mobility

Don Jayaweera, Co Secretary to the Presidential Task Force for Economic Revival and Poverty Eradication and former Secretary, Ministry of Transport, Sri Lanka

We had few policy milestones for introducing cleaner technology of vehicles in the country. The tax policy was designed based on the background empirical studies undertaken on price elasticity and income elasticity in 2010. Hybrid vehicles were given a special tax rate lower than the petrol and diesel conventional cars and dual-purpose vehicles like vans. For cars and dual-purpose vehicles, the government changed its tax policy in 2011 and 2015 and waived off import duty for the electric vehicles. Sri Lanka imports vehicles and does not manufacture vehicles. Since 2017, regulations have banned importation of internal combustion vehicles with technology lower than Euro IV emissions standards.

Between 2015 and 2020, there was huge inflow of vehicles into the country. But, fortunately, electric vehicle fleet was introduced with 0 per cent duty in 2015. As a result, their numbers increased. It started very slowly initially in 2011 but around 2013–14 the numbers grew led by hybrid vehicles. Since 2015, electric car numbers have grown rapidly.

However, during 2020–21, the government completely banned importation of all vehicles including electric and hybrid. The country is still recovering from the COVID-19 impact. But now the government is discussing allowing importation of only electric vehicles from next year and promoting charging stations throughout the country. A lot of it will be based on solar chargers. In 2016, conventional and hybrid vehicle were at 50:50 level. With some of the tax changes, these numbers are very close now because hybrid is more popular. Before the pandemic, buses catered to higher passenger market share. But during pandemic public transport has taken a hit as people have shown preference for personal vehicles. Since 2017 we have seen a huge growth in vehicle kilometres operated. Thus, the government is now discussing importation of electric vehicles and setting up solar-powered charging stations.

Excerpt from the Pan Africa Network meeting on organized by CSE on 21 October 2021

Chapter 6: On-road emissions management in Africa

How will Africa keep the vehicles low emitting during their useful life on road?

Toxic exposure from vehicles on road can be enormous and increase health risk significantly. While improvements in emissions standards and fuel quality are needed to reduce emissions from new vehicles, a strong monitoring programme for emissions from on-road vehicles and management of older vehicles are needed to keep the on-road emissions under control.

On-road vehicle emission inspection is important to keep vehicles low emitting during their useful life on the road. As majority of old, used, polluting and accident-prone vehicles are imported to Africa, vehicle inspection becomes very important to check their roadworthiness and emissions before they are shipped and imported and allowed to ply in the import country and periodic checks are necessary thereafter. Many African countries have initiated the setting up of vehicle inspection centres to monitor the roadworthiness and emissions from in-use vehicles. Though visual checks for roadworthiness are carried out at all centres, emissions testing is conducted at a few centres only. This defeats the purpose of vehicle inspection. This strategy will require more attention and detailing as on-road exposure is enormous. More robust strategies are needed to detect and repair visibly polluting vehicles, improve infrastructure for vehicle inspection and install more efficient screening systems with adequate deterrence for violation of rules.

Some of these practices have begun to take shape in several cities.

Rwanda

In Rwanda 56.7 per cent of all vehicles, excluding motorcycles, are pre-1999 and 77.2 per cent are pre-2005. While there is no age restriction on imported vehicles, car depreciation factor is applied on taxes to discourage import of old vehicles. The country implemented the East African Community (EAC) depreciation schedule through a free-on-board depreciation rate ranging from 20 per cent for two-year-old cars, 75 per cent for nine-year-old cars and 80 per cent for 10-year-old or older cars. This strategy has helped make older cars more expensive.

Vehicle inspection: The law mandates that all vehicles need to undergo emissions inspection at vehicle inspection centres. All commercial and public transport vehicles have to undergo inspection twice a year and other vehicles—such as private, public and even utilities—once a year. However, motorcycles do not undergo inspection. Non-compliant vehicles are not allowed to ply.[96]

Vehicle inspection centres: Vehicle emissions inspection is done at the inspection centres operated by the Rwanda National Police. There is one vehicle inspection centre in the capital city, Kigali, with three lanes and emission inspection equipment, four centres in the provinces and one mobile facility. The traffic police has acquired mobile and handheld emissions inspection equipment for on-spot checks. Hydrocarbon and carbon monoxide emissions for gasoline vehicles and opacity for diesel vehicles are checked.[97]

The Rwanda National Police opened three new vehicle inspection centres on 20 November 2020 in the southern province (Huye town), northern province (Musanze town) and eastern province (Rwamagana town). Each centre has two fixed lanes with the capacity to inspect at least 200 vehicles per day. These centres provide three crucial services—emissions check, advisory services to vehicle owners whose vehicles are found with mechanical faults or not in roadworthy condition and preventing road accidents. The three new centres will supplement the five fixed lanes at Remera Automobile Inspection Centre in Kigali as well as the mobile lane, which were overbooked and overloaded. This thus increases the daily inspection capacity to over 1100 vehicles, up from 500 previously. The centres test emissions, shock absorbers, brakes (including handbrake), axle play detection, wheel alignment and vehicle geometry, steering system, headlights, and the condition of the vehicle's body, among other things.[98] Currently, the three available inspection centres—Remera, Gishari in Rwamagana and the mobile lane—have the capacity to inspect up to 800 vehicles daily.

Online booking of services: The Traffic and Road Safety department of Rwanda has recently shifted from manual to online booking for vehicle inspection services. Under the new system, booking will be done through the web platform, Irembo, and through mobile banking services and the vehicle owners can choose any centre of their choice along with the time and day.[99]

Kenya

Kenya has more than 2.5 million vehicles. The motor vehicle inspection unit under the National Transport and Safety Authority (NTSA) is responsible for implementing provisions of the Traffic Act Chapter 403, Laws of Kenya and subsidiary rules relating to motor vehicle examination and Kenya Standard KS1515:2000 code of practice for inspection of road vehicles. This includes mechanical roadworthiness and environmental compliance. The Traffic Act amendment 2012, Section 16 (2) states, 'Every vehicle more than four years old from the recorded date of manufacture shall be subjected to inspection by the motor vehicle inspection unit.'

Mechanical roadworthiness: It includes checking the vehicle roadworthiness before driving; ensuring that any equipment, fittings and fixtures required are present and serviceable; not driving the vehicle if faults are present or develop; ensuring all actions taken when driving are legal; and ensuring that imported vehicles comply with the existing safety standards.

Environmental compliance: It ensures that on-road vehicles do not pollute and emit beyond the tolerable limit as specified in the KS1515:2000 code of practice for inspection of road vehicles.

Table 9: On-road vehicles inspection

Engine type	Carbon monoxide	Hydrocarbon
Normal petrol engines with carburettors (1975–1986)	<4.5% volume	<0.12% volume per 1200 ppm
Normal petrol engines with carburettors (1986–1992) & (1992–2005 for catalytic vehicles used before 2005)	3.5% volume	0.12% per 1200 ppm
Vehicles with catalytic convertors (2nd generation of EFI-1992–2002) used after 2005	0.5% at idling speed and 0.3% at test ranges (2000–2500 RPM)	200 ppm
Vehicles after 2002 and used after 2005 (when leaded fuel was banned)	0.3% at idling and 0.2% at test ranges (2000–2500 RPM)	200 ppm

Vehicle inspection centres: There are 17 vehicle inspection centres in Kenya operated by the government whose total annual inspection capacity was around 260,000 vehicles in 2016 and has increased to 450,000 vehicles. The actual target is 500,000 vehicles distributed across all centres. At present, only Public Service Vehicles (PSVs) and commercial vehicles are subjected to inspection. *Matatus*, buses, tuk-tuks, taxis and trucks come for annual inspection. Only visual tests

are done to check if the vehicles are fitted with a speed governor and are in good mechanical condition. Emissions testing is however limited. From January 2015, all private vehicles more than four years of age were to undergo the inspection.

Challenges: While the Nairobi inspection centre at Likoni has three lanes, Mombasa has two lanes and the rest have one lane each. According to the inspection department estimate, KSh 2 billion is required to modernize the vehicle inspection centres to increase their annual inspection capacity to cater to around 2.5 million vehicles. Only six (Likoni, Mombasa, Kisumu, Nakuru, Embu and Eldoret) out of the 17 centres are feasible for modernization due to physical constraints. After modernizing the six centres, expected number of inspected vehicles will increase to approximately 800,000 vehicles and still leave an approximately 1,200,000 uninspected vehicles. The other challenges include not enough test equipment in all the test centres, repairing all the inspection equipment to be in good working order, further training of the inspectors, no policy on scrappage and trade-in, and no policy on motorcycles and three-wheelers in terms of emissions control. The Likoni Road and Mombasa Miritini centres have been upgraded and are capable of carrying out emission tests. Support is being sought to fund upgradation of other centres.

Revamping required: Vehicle inspection centres need revamping. More new and modern emission testing equipment need to be secured. Motor vehicle inspectors need to be further exposed and trained on emission testing. KS 1515:2000 needs revision and emission standards need to conform to Euro IV standard. Approved garages, centres and private entities should also be licensed to conduct vehicle inspections on behalf of the NTSA. There should also be a policy on motorcycles and three-wheelers in coordination, management and emission control and hybrid vehicles. Scrappage and trade-in of old vehicles should be encouraged. Emission standards across the region should also be standardized.[100]

KS1515:2020 Code of practice for vehicle inspectors was revised to KS 1515:2019 and now caters for a range of vehicles including electric and hybrid. Other standards on bus body building (KS:372) and on speed limiters (KS:2295:2018) are also being implemented.[101]

For used vehicles, Quality Inspection Services Inc. Japan does pre-export verification of conformity services in Japan, United Arab Emirates, the UK, Thailand and South Africa for Kenya Bureau of Standards (KEBS). Used vehicles are checked for radioactive contamination and verification of odometer integrity as per relevant Kenya Standards or approved specification. Vehicles,

mobile equipment and spare parts coming from Japan and UAE are subjected to inspection for relevant standard conformity.[102]

Uganda

Vehicle emission challenges in Uganda include used vehicles and 15 years age cap on vehicle importation, fuel quality, lack of emission standards enforcement, legal regime on emissions control and monitoring requiring reform (national standards are being drafted), and lack of real-time air quality monitoring facilities (two private facilities in Kampala monitor air quality). Despite the challenges, Uganda has initiated vehicle inspection for on-road vehicles to check roadworthiness and emissions.

Vehicle inspection: Till 1998 vehicle inspection in Uganda was conducted by the Uganda Police as delegated function by the Ministry of Transport. It was stopped due to corruption allegations and collection of revenue through annual road licence. However, police continue to inspect vehicles involved in road crashes and those suspected to be in poor condition through roadside enforcement.

Later, the private sector was involved and the process started in 2001. Initially, a proposal was made to contract local garages for vehicle inspection but this idea was dropped. A study to determine feasibility of privatization of vehicle inspection centres was recommended. This feasibility study conducted by the World Bank submitted its report in 2007 and recommended awarding two firms for vehicle inspection and not involve local garages or motor repairers but rather build their capacities in repairing vehicles. The Ministry of Works and Transport (MoWT) decided to acquire one private firm for which the tender process started in 2007, got cancelled in 2008 and restarted in 2009.

On 17 March 2015, the MoWT signed a contract with SGS SA to provide mandatory motor vehicle inspection services. The contract allowed SGS to acquire land, build and operate the inspection stations and charge a user fee for the services. Vehicle inspection thus began from 28 November 2016 and is applicable to all vehicles. The exempted vehicle categories include private vehicles which are two years old from January 1 of the manufactured year, motorcycles and goods vehicles of 1 year or less from January 1 of the manufactured year and vintage vehicles registered in Uganda before 1 January 1980. The deadline caused huge traffic at the stations and thus the enforcement of the deadline was suspended by the parliament in June 2017. Over 60,000 vehicles have been inspected so far.

Vehicle inspection centres: Four fixed vehicle inspection centres have been constructed around the Greater Kampala Metropolitan Area (GKMA) and three hybrid mobile vehicle inspection stations in the upcountry areas of Mbale, Mbarara and Gulu are available to complement the fixed stations. The four fixed centres in the GKMA are Namanve VIS (7 inspection lanes—2 HMV, 4 LMV and 1 motorcycle); Kawanda VIS (5 inspection lanes—2 HMV, 2 LMV and 1 motorcycle); Nabbingo VIS (3 inspection lanes—2 LMV and 1 motorcycle) and Namulanda VIS (3 inspection lanes—2LMV and 1 motorcycle). The vehicle inspection system focuses on automated testing of the brakes, axle play detection, headlight aim testing, sound level testing, suspension testing, wheel alignment test and emission tests with diesel smoke opacity testers and exhaust gas analysers. Under-vehicle inspection is manually carried out.[103]

Nigeria

Vehicle numbers in Nigeria are estimated to be more than 15 million and increasing. Challenges include inability to fully implement and enforce existing laws due to lack of adequate equipment to carry out required tests (regulations guiding speedometer, brake, emissions checks, etc.); inability to carry out vehicle emissions tests leading to environmental pollution due to non-roadworthy vehicles; presence of non-roadworthy vehicles plying on roads; and poor maintenance culture due to ineffective vehicle inspection systems.

All vehicles and engines are presented for inspection based on the provision of the Road Traffic and National Vehicular Emission Control regulation. Emission tests are conducted and vehicles whose emissions level surpasses the standards are rejected.

Abuja Computerized Vehicle Testing Service (ACVTS) is the first computerized vehicle inspection centre in Nigeria. Temple Resources Limited was licensed by the Federal Capital Territory Administration (FCTA) Abuja in November 2012 to build and operate a network of six modern computerized vehicle PTI stations comprising 36 emission testing nodes to cover FCTA territory under public private partnership. Over 30,000 emission tests were conducted on different engines and vehicles till 2015. But the emission programme is strictly advisory for now as the FCT Road Traffic Regulation does not spell out emission standards for different categories of vehicles.

An analysis of the emission tests carried out on around 25,000 vehicles at ACVTS revealed that over 85 per cent of vehicles presented did not meet the standards

prescribed in the National Environmental (Control of Vehicular Emissions) Regulations 2011; Schedule III & Regulation 8(1) and 10. A concerted effort for emission control law enforcement in partnership with the law enforcement agencies was needed.[104]

Some steps have been taken to establish on-road emissions inspection to keep vehicles low emitting during their useful life on the road. Vehicle inspection centres have been set up to monitor the roadworthiness and emissions from in-use vehicles. The vehicles are checked for roadworthiness—suspension, chassis, headlights and emissions. There are four vehicle inspection centres in Abuja located in Onex, Lugbe, Kugbo and Gwagwalada. These are being operated on a PPP mode. However, the programme is still very nascent and not rigorous. While private cars have to undergo inspection once in a year, it is twice a year for commercial vehicles. However, two-wheelers are exempted from the inspection.[105] So far, 5 million plus vehicles have been tested and 3 million plus vehicles failed.

All private and commercial vehicles have to mandatorily undergo a routine inspection at Lagos State Computerized Vehicle Inspection Service (LACVIS) for compliance to regulations. The legality and roadworthiness of the vehicle is checked during routine inspection. Vehicles failing the routine inspection are required to rectify the problems and revisit for a re-inspection in which the failed items as recorded during previous inspection are re-inspected. LACVIS is also required to verify a new commercial vehicle before its registration to ensure that it complies with the standards set out by the authorities.[106]

This strategy will require more attention and detailing as on-road exposure is enormous. More robust strategies are needed to detect and repair visibly polluting vehicles, infrastructure for vehicle inspection and more efficient screening systems with adequate deterrence for violation of rules.

Ethiopia

Emissions from the on-road vehicle fleet pose a serious pollution challenge. An ageing fleet and poor maintenance can increase emissions much more than vehicles are designed to emit. Sometimes even inbuilt technical defects that go unnoticed can escalate emissions.

Vehicle numbers, though small, are increasing rapidly in Ethiopia. The country has a high share of used/second hand vehicles. Nearly 85 per cent of the vehicles imported in the country are used vehicles, which makes the air pollution problem

a very serious concern. There were 0.59 million vehicles in Ethiopia till June 2015. Addis Ababa constituted 62 per cent of the country's registered vehicle fleet. The country had 40 per cent of cars and two-wheelers. While majority of cars were old, greater than 11 years, two-wheelers were in the age range of 7 to 9 years. Most of the other vehicles like Bajaj, buses, cargo and trailers also fell within 2 to 3 years till 7 to 9 years. Some exceed 11 years. The vehicle age distribution clearly showsed that the country had an old fleet contributing to emissions. Keeping emissions low during the useful life of the second-hand imported vehicles is a challenge and requires stringent emission inspection. Registered vehicle numbers have increased to 1.51 million.

Efforts are being made in Ethiopia to organize vehicle inspection centres to address the problem of in-use emissions. The Transport Authority is the nodal agency responsible for vehicle inspection. According to the Authority regulations, all vehicles are required to undergo annual technical inspection at a designated vehicle inspection centre. In order to address in-use emissions, vehicle roadworthy test is being conducted along with exhaust emissions measurement against the standard set by the Authority. Implementation challenges do occur. Vehicles are to display the annual vehicle inspection stickers.

In order to address the in-use emissions issue from these polluting second hand vehicles, it is important that personal vehicles should be subjected to vehicle inspection including emissions testing in every 3 or 6 months. Other vehicles like Bajaj, taxis and mini-taxis should undergo inspection every six months. Heavy-duty vehicles like buses and trucks should also undergo technical inspection at the inspection centres in six months and an annual fitness test. Grossly polluting vehicles will have to be tackled with good inspection programme and smoky-vehicle checks. Smoky-vehicle inspection based on spot check and on-road surveillance, high penalties and instant removal from the road can make a difference inside the city as well as along various entry points.[107]

Chapter 7: Electric vehicle programme

How zero emission transition is an opportunity in Africa?

Electric mobility is an opportunity in Africa as internal combustion engines are taking time to move to a cleaner benchmark. Given the air quality and climate change mitigation challenges, there is need for a leapfrog strategy to move directly to zero emission vehicles (ZEVs). There is an opportunity in electrification of two-wheelers, para-transit and buses in cities. Two-wheelers are popular in the congested cities. Some countries have large two-wheeler markets and huge potential to adopt electric two-wheelers (E2Ws). UNEP is supporting the electric mobility programme in different countries of Africa. The programme has been initiated in Kenya and is an opportunity for other countries. E2W assembly has started in the region and can be a feasible first step towards electrification and zero emissions. Nigeria is among the few African countries which have manufacturing and assembly capacity that can be leveraged for assembling of E2Ws at scale and at affordable rates.

It is important to develop a cohesive electric vehicle policy for the countries individually and at the regional level to guide this transition. This needs to set targets for vehicle segment-wise electrification, begin incentive programmes for demand creation, make a revenue model and cross subsidy policy to fund the programme, plan charging infrastructure, and localize production/assembly of two-wheelers, battery management systems and battery recycling systems. Two-wheelers can be prioritized for the first phase of transition. Electrification of para-transit and buses can also be explored. This can provide substantial air quality and climate benefits.

Kenya

In 2018, number of newly registered motorcycles (known as boda-boda and commonly used as taxis) in Kenya was estimated at 1.5 million. This was expected to grow by more than five million by 2030. As these are inefficient and poorly maintained, a pilot electric bikes project was launched. Joyce Msuya, Deputy Executive Director, UNEP said during the launch of the pilot electric bikes project, 'Kenya is importing more motorcycles than cars, doubling its fleet every 7–8 years. These are generally inefficient and poorly maintained polluting motorcycles.

Kenya's electricity is very green with more than 80 per cent generated by hydro, solar, geothermal and wind. Shifting to electric bikes in Kenya, Rwanda, Uganda and elsewhere will reduce costs, air pollution and greenhouse gas emissions, as well as create jobs.' [108]

Pilot electric bikes project: UNEP launched a pilot electric bikes project in Nairobi's Karura Forest on 2 March 2021. Forty-nine motorcycles donated by Shenzhen Shenling Car Company Limited (TAILG) were part of the pilot project based on a study implemented by the Energy and Petroleum Regulatory Authority, the University of Nairobi and Sustainable Transport Africa. A host of local partners, including ministries, and national and sub-national authorities are also included.[109] As part of this project, 99 electric motorcycles were provided to four partners—Karura Forest, Kenya Power and Lighting company, Power Hive and Kisumu County.[110] The initiative in Kenya is supported by UNEP with funding from the International Climate Initiative of the German Ministry for the Environment. This project is expected to reduce air pollution, improve national energy security and create green jobs. This pilot project is intended to help policy makers assess the barriers in uptake of the much-needed technological shift towards electric bikes, and to demonstrate that the shift is feasible and within reach. After 6 to 12 months, this project will be replicated in Uganda, Ethiopia, etc. [111]

Battery charging: Investments in battery charging infrastructure will be required to scale up the electric mobility transition. Kenya's electric power generation capacity is sufficient to support the charging infrastructure. However, while demand for motorcycles is high, particularly in rural areas, distribution networks are inadequate. However, this challenge may be tackled by using solar energy, setting up charging stations, consulting boda-boda operators and using lithium-ion batteries.[112]

Electric vehicle regulations: The government through the Kenya Bureau of Standards has developed electric vehicle standards. The government in its National Energy Conservation Strategy 2020 has also set a target of five per cent electric vehicle share for all vehicles coming into Kenya by 2025.[113]

Rwanda

Rwanda aims to reduce 38 per cent emissions by 2030. Electric vehicles are estimated to reduce 9 per cent of the emissions under the country's 10-year climate action plan. In order to promote electric vehicles, Rwanda government has

announced incentives in a cabinet meeting held on 15 April. Aimed at increasing the number of electric vehicles and motorcycles and keeping them cost-effective, the incentives include electricity tariff, infrastructure related tax exemptions, etc. on electric vehicles, plug-in hybrid electric vehicles and hybrid electric vehicles. All these incentives aim to boost the electric vehicle industry. Rwanda's long-term goal is to become carbon-neutral as articulated in its Vision 2050.[114]

Charging infrastructure: Rent-free land for charging stations will be provided in case of government owned land. Provision for charging stations will also be included in the building code and city planning rules.

Lower electricity tariff for charging: Gas stations serve as charging stations for electric vehicles. Electricity tariffs for charging stations will be priced at the industrial tariff level (large industry category) at around RWF 94 per kilowatt-hour, significantly less than the tariff charged for residential consumption. Reduced tariff will also be applicable during off-peak hours from 11 pm to 8 am.

Tax exemptions: A vehicle when imported in Rwanda has to pay 25 per cent import duty, 18 per cent Value Added Tax (VAT) and 5 to 15 per cent excise duty depending on the engine size. In order to reduce the ownership and maintenance cost of electric vehicles, a range of tax exemptions have been provided, which include import and excise duty exemption and zero rated VAT on electric vehicles, spare parts, batteries and charging station equipment; and exemption of 5 per cent withholding tax on spare parts, batteries and other equipment.

Investor incentives: Incentives will be provided in the investment code such as 15 per cent Corporate Income Tax (CIT) and tax holiday for companies manufacturing and assembling electric vehicles.

Business preference: Free license and authorization will be provided for commercial electric vehicles. The government will also de-risk the business by guaranteeing a market, where preference will be given to electric vehicles for government-hired fleet.[115]

Chapter 8: Public transport in cities of Africa

How Africa with a practice of public transport usage has better opportunity to make mobility transition?

Cities need to build public transport at scale for the massive transition to clean and low-carbon mobility. In several cities across Africa, bus based formal public transport systems are taking shape. Buses are the prime movers of people among all formal public transport systems. But for buses to be a game changer, their services need to be frequent, reliable, comfortable and affordable for all. This also requires additional infrastructure and IT-based systems for deployment, to access services and to provide passenger information services.

But, currently, most cities do not have enough buses, the bus stock is very old, bus services suffer from low utilization, poor maintenance, frequent breakdowns, fuel inefficiency, and face severe infrastructure constraint. Fare revenue is limited and other funding sources are nearly non-existent. Bus sector reform therefore has to be the priority to modernize the system, improve service level and financial sustainability. Bus routes also need to be rationalized for multi-modal integration and maximum population coverage in the city.

It is encouraging to see that several cities have begun to reform bus sector, modernize the bus fleet and also adopt more innovative approaches of dedicated bus lanes for bus rapid transit (BRT) to improve the experience of the bus service.

Johannesburg in South Africa and Lagos in Nigeria showcase BRT. Rea Vaya BRT in Johannesburg and BRT-Lite project in Lagos are success stories. Other countries are Tanzania, Uganda, Senegal, Kenya, Ethiopia, Ghana, Bostwana, Rwanda and Ivory Coast. The uniqueness of the Johannesburg and Lagos BRTS is the integration of the affected taxi association and transport operators into formal BRTS. These examples present the learning curve in the region that needs to inform change across all cities.

Johannesburg BRT

The city of Johannesburg approved a public transport project in 2006, known as the Rea Vaya ('we are going') BRT to improve the quality of life of residents.[116] The first phase of this inclusive and integrated BRT started in 2007.[117] A MoU between the city of Johannesburg and public transport operators in the minibus/taxi industry was also signed in 2007. The objectives of this BRT include building a leading, responsive and active transportation sector in the city which works in partnership with stakeholders and residents; planning, policies and coordination for integrated and sustainable transport; promoting public transport, walking and cycling as transport modes of choice; building co-responsibility and a value-based culture to enable behavioural change towards transport issues; and providing high-quality, safe, accessible, affordable and environmentally friendly public transport services.

Inclusive and integrated BRT: Series of consultations were held with diverse stakeholders such as the existing minibus taxi operators and others. It emphasized involving the former taxi drivers in the new system as bus operators or bus maintenance managers. Other services such as feeder vehicles, pedestrian corridors, bicycles, metered taxis and private cars were also integrated in the system.[118]

The bus route starting from Soweto passing through Noordegesig, New Canada, Pennyville, Bosmont, Coronationville, Newclare, Westbury, Westdene, Melville, Auckland Park and Parktown and linking to the CBD was operational in October 2013. Rea Vaya buses carried 37,579 passengers daily by June 2015.[119] This BRT operating more than 270 busses across 58 stations is estimated to carry 45,000 passengers daily. Smartcards are used to pay the bus fare by tapping the scanner while boarding and alighting.[120] The bus frequency is 3 minutes during peak hours. Real-time monitoring and tracking of buses, routes and stations is done by the control room. Bus drivers are communicated with to ensure timely plying of buses and also guiding in emergency situations.

Project phases: Phase 1A operations began in 2009 and got implemented in two phases—31 August 2009 and February 2011. With 41 new articulated buses and 102 solo, double-sided door buses and stops at 31 stations in the central median, the bus services are operated by Piotrans Pty Ltd. It is owned by 313 shareholders, former taxis operators on similar routes with 12 years of operating contact period. This led to withdrawal of 585 taxis and many were scrapped.[121] Phase 1B began operating on 14 October 2013. With 41 articulated high floor buses and 93 solo 12-metre double-sided high floor buses, this phase added 18 km of trunk, feeder and

complementary routes, with 18 new enclosed median stations. While the buses are owned by the city, Litsamaiso Pty Ltd operates and maintains them. Bus operating contract agreement between the city and bus company monitors the operating performance. Phase 1C in the north-east quadrant of Johannesburg comprises 16.6 km of trunk road network, with 242 buses, 45 of which are articulated and includes 30.5 km of extensive walking and cycling paths and maximizes integration with other modes of public transport.

Funding: Majority of funding for this project has come from the South Africa government and the city of Johannesburg. The latter also leads the BRT project. The infrastructure construction cost was provided by the Public Transport Infrastructure and Systems Grant (PTIS) from the national government grant funding. Bus operating costs are met by fare revenue and city and national government operational subsidies. Station operating costs mostly from national government operational subsidy and shifting to the city over time. The city of Johannesburg facilitated ECA funding from Brazilian Development Bank (BNDES) for phase 1A bus procurement at good interest rates. While it was cost effective to the operator, it was very costly for the city and also holds a number of risks including a contingent liability. For other phases, the city plans to own buses. Bus operating companies are responsible for bus maintenance.

Impacts: BRT led to social, economic, urban and technology impacts. Passengers from all socio-economic groups and races use the buses, contributing to improved social cohesion. It led to creation of jobs during construction phase and also in bus and station operations. Land use and other development control measures improved densification along the corridor. Technologically advanced buses have been purchased—Euro IV standard for phase 1A and Euro V standard for phase 1B. The buses use automatic bank-based fare collection.

Rea Vaya BRT is the first BRTS in South Africa and links Soweto to the city centre. According to Daisy Dwango, director of planning and policy of Johannesburg Transport department, 'a number of affected taxi associations were identified and negotiations were done. The ultimate goal was to ensure that those operating or getting affected by the BRT will be the shareholders in the bus operating companies that will take over the BRT system.'

Lagos BRT

Nigeria has taken an important step forward in the city of Lagos. A pilot BRT scheme called BRT 'Lite' has been designed and successfully implemented in March 2008. This was the first BRT scheme implemented in sub-Saharan Africa. The Lagos BRT introduced to reduce the public transport challenges included the gateway corridor linking suburban areas of Lagos to the major CBD, that is from Ikorodu to Lagos Island. BRT implementation has been done in two phases—BRT Lite and BRT Ext.

BRT Lite: In 2008, Lagos launched a BRT Lite corridor with 22 km route, three terminals, 26 stations and 220 high-capacity buses. The system was designed to carry 60,000 passengers a day by 2010. It carried 220,000 passengers per day, with more than 100 million person-trips being made in the first 21 months of operation. It also led to 30 per cent reduction in average fares, reduction of 40 per cent travel time and 35 per cent waiting time of commuters and direct employment for 1000 people and indirect employment for over 500,000 people. The Lagos Metropolitan Area Transport Authority (LAMATA), a strategic public transport authority, operates the system focussing on user needs and deliverability.

LAMATA: LAMATA is also a unique experiment in which the informal para transit operators have been integrated for operations. This is a critical intervention as the informal para transit system dominates across Africa. This is a point of tension and conflict when formal and bigger public transport systems are brought in place. Lagos has therefore done the innovation in which para transit operators have been incorporated to organize the running of the BRT buses. The franchise contract stipulates that it is the Lagos government's responsibility to provide the operating infrastructures (corridors, terminals, shelters) in good condition while each operator is responsible for the purchase of vehicles and profitability of their operation. Through this initiative, the road network efficiency of the Lagos metropolitan area has been significantly improved.

According to LAMATA, daily trips in Lagos Metropolitan Area by all modes (including walking) in 2012 were 20 million and 40 per cent were met by walking. The daily trips were expected to increase to 40 million by 2030. To prevent steady erosion of walking and public transport trips, reliable, efficient and comfortable public transport systems was thought to be put in place.

Implementation framework: The infrastructure, regulation, enforcement, route planning and operational specifications are administered by the government. The

private sector provides the rolling stock, recruits and trains crew, and manages operations. The LAMATA is responsible for regulation, infrastructure provision, BRT law enforcement and provision of security and traffic safety measures. The private sector including operators, financing bank, ticketing system provider and media each have concerned role and responsibilities including acquisition of buses, operation of the scheme, acquisition and management of staff, rolling stock funding, revenue protection strategy and public awareness.

The BRT extension route: An extension of the BRT-Lite by 13.5 km from Ikorodu to Mile 12 started in 2012 and was completed in 2015. It is a median running lane carrying 250,000 passengers per day. Third BRT from Oshodi to Abule Egba is under construction.

Funding: Funding for the BRT included government budgetary allocation, developmental banks and donors such as World Bank and AFD and transport fund collected from plate number, vehicle license, driver licenses, hackney permit, etc.

Control centre: A control centre is set up to monitor and coordinate bus operations. It includes responding to mechanical breakdowns, managing on-time performance and countdown display and implementing emergency response procedures.

Impact: A range of impacts have been associated with BRT such as 40 per cent fare reduction, 25 per cent reduction in travel time and waiting time both, creation of more than 2,000 jobs and 10 per cent reduction in air pollution.[122]

It is one of the unique initiatives in African region where impacts of public transport interventions on the commuting choices of people have been assessed. The LAMATA assessment of the extension project shows that the average public transport waiting time has reduced from 30 minutes to 10 minutes which is a reduction of 66 per cent. The journey time has reduced from 120 minutes to 30 minutes, which is a reduction of 75 per cent. This has led to reduction of heat-trapping CO_2 by 16 per cent. This has also made public transport usage a lot safer. Public transport related accidents have reduced by 50 per cent. This mass transit will be integrated by a common ticketing system.

The government is also working to develop waterways to be integrated by the BRT and rail. Further estimates have been carried out to show the future impacts of BRT and light rail on modal share by 2030 compared to the business-as-usual

(BAU) scenario. According to this estimate, the car modal share will reduce to 13 per cent from the 21 per cent in BAU. There will be a huge increase in work trips by high-capacity buses, BRT and rail by 2030. LAMATA has also projected that minibuses will be eliminated by 2030. This will have to be reviewed again as the minibuses will remain an important part of para transit. The combined share of trips by BRT and rail is expected to increase to 39 per cent by 2030 as compared to the 3 per cent in BAU. The share of high-capacity buses will increase to 43 per cent as against 6 per cent in BAU by 2030. The Lagos State Transport Master Plan is set to reduce GHG emission by 45 per cent by 2030.

According to Taiwo Olukayode, then deputy director of LAMATA , implementation of the Lagos BRT-Lite was preceded by a law to pave way for implementation of the system. 'A political champion, the governor, was necessary to see through the BRT implementation. Important elements were the negotiations ensuring that existing public transport operators were integrated into the new system, a proper financial model and integration into the feeder network.'[123]

Dar es Salaam BRT

Dar es Salaam BRT is a closed BRT with high design standards. Pedestrianization of congested areas and travel demand management (TDM)-based parking supply has been planned along with the corridors. This BRT has succeeded in creating political awareness to look into transport as a separate issue and not along with road construction. It has sorted out the roles of infrastructure providers and operators in the city of Dar es Salaam and created public awareness about the need for sustainable mass transit in Tanzania. It has sensitized the existing *daladala* operators about the need for efficient public transport by making them an active part of the decision making process.

In 2007, the government developed and approved an integrated BRT trunk network. BRT was conceived by Dar es Salaam City Council (DCC) Mayor's Vision and the DCC project implementation team led its preparation. Dar Rapid Transit Agency (DART) was created under the Ministry of Local Government with oversight by the Ministerial Advisory Board. Implementation agencies included the DCC, TANRoads and DART. The latter two were responsible for infrastructure and resettlement action plan (RAP) and operations respectively. The DCC and municipal roles were overshadowed by the central government.

BRT phase 1 (2008-16): The BRT phase 1 infrastructure included 21 km trunk corridor, 27 stations, 5 terminals, 1 depot and 4 transfer stations. However, there

were implementation challenges such as delays in the implementation of the Resettlement Action Plan in terms of capacity, coordination, fund release, land-use change and BRT only street; failures in initial procurement process in 2008; inadequate engineering designs such as unmapped ground utilities and weak supervision engineer and infrastructure cost overruns.

Preparation for BRT operations included private sector operators (PPP)—bus operator 1 (interim operator), bus operator 2 (competitively selected), fare collector and ITS operator (competitive) and fund manager (competitive); hiring of transaction advisors in 2014, road show in June 2014 and procuring 305 buses (177 trunk buses—150 passengers; and 128 feeder buses—80 passengers). PPP process for competitive packages is yet to be concluded.

For contracting of an interim BRT operator, interim service providers (ISP) for trial services and existing minibus operators under former public operator (UDA) were included and ISP contract was signed on 24 April 2015 for supply of 5 BRT trunk articulated buses (18 m of 150 passengers), 71 BRT feeder buses (12 m of 80 passengers) and simple electronic ticketing system (not automated fare collection system, AFCS). In August 2015, a mismatch with actual supplied services (39 trunk articulated buses, 101 feeder buses and AFCS with ITS) was noticed. This resulted in renegotiation of the contract in 2016 to accommodate all services. The services began in May 2016 and 200,000 passengers were carried per day during interim operations.

But there were teething problems such as deterioration of operations with overcrowded buses, long ticketing queues, unreliability of services and high driver turnover; inadequate DART capacity; court injunctions by the ISP; hesitation in PPP processing; flooding along the trunk line and inadequate communication.[124]

PPP challenges: The challenges include bidding failure in 2018 for second operator; updating operations and PPP feasibility studies in 2019— low fare levels and adjustment challenges (political and income), operators remuneration ('access fees' versus 'per km') and need for critical government support for viability gap funding and government doing due diligence and developing its own AFCS system.[125]

Institutional challenges: Though Dar BRT was conceived by the Dar City Council mayor, DART was created by PORALG under executive agencies act, thereby reporting to central government; Ministry takes decision due to DART's semi autonomy; there are HR issues such as not being able to attract right skills from

market, staff turnover, staff incentive and retention, accountability (staff decisions not directly under DART) and compensation and benefit issues; and issues with autonomy and stronger ties with LGAs critical for streamlining decision making and collaboration in Land Use Planning (TODs, etc).

Chapter 9: Informal public transport system in Africa

How Africa is taking innovative approaches to integrate informal with formal public transport systems to leverage its strength?

There is very little understanding of the role that intermediate public transport—like the *matatus*, *boda bodas*, etc.—play in meeting the overall travel demand in cities. In most African cities, these forms of transport meet nearly 60–70 per cent of the travel demand. These can move people quickly, flexibly, and safely in cities. A range of such services have emerged in cities of Africa. These are high-frequency and low-occupancy vehicles that can effectively cut dependence on personal vehicles especially for short distance travel, for connecting formal public transport and for last-mile connectivity.

But these—that are common across the developing world—have not been given the due recognition in mainstream transportation planning. Instead, this has led to increased conflict with formal public transport and curtailment of their services from key routes, which hurts the overall travel needs in the city. It has become necessary to adopt new model of management for these services and integrate these services to keep people public transport oriented. These are also important sources of livelihood security. These services are largely disorganized, ad hoc and have poor service quality.

There is enormous potential to improve these services to meet the commuting demand. By formalizing and reorganizing them, it is possible to improve service quality, monitoring and enforcement. It is possible to mandate targeted clean fuels and technology and also electrification of this segment. It is very encouraging to see the trend towards designing their deployment to improve multi-modal integration. It is also encouraging therefore to see some initiatives to improve these services in several cities of African nations.

Nairobi

***Matatu saccos* and digital *matatus* in Nairobi:** Matatus or minibuses are the informal public transport in Nairobi. Estimates show matatus transport 12 million commuters every day in Kenya and meet nearly 70 per cent of demand for motorized travel. These ply on specific routes between downtown Nairobi to the suburbs and charge 30 KSh for a ride. The government regulates the matatus. In Kenya, matatu operators have been reorganized as cooperatives. *A*bout 87 cooperatives or saccos have been formed in Nairobi. A sacco should have a minimum of 30 matatus. The government is trying to phase out commonly seen 14-seater matatus and replace them with high capacity matatus. Orders have been passed in the past banning matatus from central business district but implementation couldn't be done. As these are the lifeline of Nairobi, banning them or keeping them off the roads for a single day brings the capital city to a halt. Instead of banning them, the government should think of strategies to better regulate them and integrate them in the transportation system. These are very important for last-mile connectivity and as feeders to public transport. These systems should be reorganized well to improve efficiency and deployment. The Nairobi Metropolitan Services (NMS) has plans to relocate matatus in phases from CBD to terminals outside.

Matatu infrastructure and design is equally important from the road safety point of view. A pilot study conducted by the NTSA and National Police Service found an estimated 35 per cent of road traffic deaths in Nairobi occurred within 20 metres of matatu stages. It highlighted infrastructure design flaws around these sites as well as rogue behaviour by drivers and lack of safety consciousness among pedestrians. A spot check of the matatu terminals in Nairobi shows that many pickup and drop-off points around the city lack safety features such as designated crossing points or protected sidewalks, thus exposing pedestrians to harm or even death. Other factors such as poor visibility and drunk driving can also be responsible as the accidents occurred either early morning or late evening or night.[126]

Matatu routes were organized into eight major corridors used to codify clear routes and bus stops. This structure was used to develop a coding system based on branching and rotation to give each stop and route a unique, logical identifier. The initiative of Digital Matatus is an important one. This transit data is on the publicly accessible GTFS exchange.

Addis Ababa

Cooperative of minibus taxis in Addis Ababa: Informal public transport systems like minibus taxis (blue and white taxis) in Addis Ababa meet 73 per cent of the public transport demand. These are reliable, affordable and provide high frequency public transport services. These are also known as 'blue donkeys' and have a capacity of 11 passengers. Around 10,000 to 12,000 privately run minibus taxis ply in the city. These tend to choose own routes to avoid traffic. Though these are overcrowded, polluting and known for dangerous driving, yet these are the city's lifeline due to their service frequency and affordable fares. These also move upcountry, for example from Addis Ababa to Bahir Dar.

An assessment by Ethiopian Institute of Architecture in 2011 found that transport fares have increased much more than household income. This has made its services unaffordable for a large percentage of the population.

In 2011, the government introduced the zonal taxi transport system. The government has set and regulates the operational zones and destinations of these minibus taxis. Based on the zoning system reintroduced in 2011, owners of blue and white taxis are organized under 13 owners' associations. Number of members in each association varies, with a minimum number of 500. These associations engage in service route management. There were plans to reorganize the 13 minibus taxi owners associations into two bigger share companies. Members of the associations are expected to change their vehicles into midi buses, with a capacity of up to 24 passengers.

A study conducted to assess the effect of zonal taxi transport system on the level of service in Addis Ababa observed certain changes in the taxi transport industry. Taxi owners became organized and established taxi owners' association. Taxi station attendants were also legally organized. Each taxi is required to have a destination sign posted on the roof of the vehicle and taxi transport tariff posted inside the vehicle. The service quality also improved as observed from operators' behaviour, the way taxi users get into taxis, waiting time to get taxis, time to reach taxi terminals and comfort of seating in taxis. As taxi operators had to stick to designated routes unlike earlier, their livelihood was affected.[127]

Despite all the challenges, these informal systems are important and should not be phased out or destroyed. Bigger formal systems like LRT and BRT can cater to select routes and will be more expensive. These minibus taxis are efficient and affordable public transport modes and can also complement LRT and BRT

as feeders. These minibus taxis need supportive systems for improvement and integration with the city's transportation system. Congestion will worsen if these are replaced by cars.

Addressing challenge of *boda-bodas* and their regulation and integration: Boda-bodas or motorcycle taxis are also an important informal public transport mode. As these are mainly two-stroke engines and polluting, the government should think of replacing these with four-stroke engines, enforcing stricter safety regulations for them and integrating these in the transportation system as these are last mile connectivity modes for passengers. The NTSA and regional authorities have been enforcing the Motorcycle Regulations 2015 in an attempt to tame rogue cyclists. The regulations prohibit riders from carrying more than one passenger on a motorcycle. Additionally, riders are required to have valid documentation, ensure that they and their passengers wear reflector jackets and helmets, and make sure that their headlights are on at all times. The law also applies to owners of motorcycles who are required to, among other things, ensure that the riders working for them have documents such as licences, the motorcycles are roadworthy and are insured, and they have two helmets and two reflector jackets. Dealers are also now required to issue two helmets and two reflector jackets for every motorcycle that they sell. The NTSA is mandated to revoke dealership licences of non-compliant vendors.[128]

Chapter 10: Walking and cycling in Africa

How can Africa with very high share of walking and non-motorized transport leapfrog to accessible and liveable cities?

Active mobility: Walking and cycling are central to low carbon zero emissions mobility that has enormous opportunity for scale in Africa. Even though the majority walk and the compact urban forms of most cities require short distance travel that is walkable and cyclable, not much attention has been paid to develop well designed infrastructure for safe access. This is a critical intervention to also make public transport strategy successful. Safe access to public transport modes is essential for overall scaling up of sustainable transport options. A good sign is the trend towards building properly designed walking and cycling infrastructure in several cities across Africa.

It has become necessary to have national and city-level urban transport policy to recognize the importance of walking and cycling. It has also become necessary to adopt urban form-based code to promote compact city development with short travel distances and prevent urban sprawl that increases travel distances and automobility. It is necessary to adopt street design guidelines that are more oriented towards safe access for people. Integrated street network development and high street density are important enablers. Cities need to conduct walkability audits and promote zero tolerance for traffic accidents.

If not acted upon on time, cities can marginalize the needs of the pedestrians and cyclists while giving priority to the movement of vehicles. It is encouraging that several steps are being taken in this direction across several cities. The change is certain.

Uganda

Uganda NMT policy: Despite increasing motorization in Uganda, NMT modes are still the primary transportation in the country. Majority of people depend on walking and cycling for their basic livelihoods. Walking is dominant in both rural and urban areas. Nearly 50 per cent of all trips in Kampala are made by walking. Around 45 per cent of all trips in the high-income groups are also by walking. Over 50 per cent of all market traders and customers use NMT. This includes 28 per cent walking and 22 per cent cycling.

In 2011, the MoWT recognized the need to develop an NMT policy for Uganda. NMT policy was framed with the support of UNEP's Share the Road programme to increase awareness of walking and cycling; and support effective design and infrastructure provision at a national level. The policy acknowledges, 'the great majority of Uganda's roads have no infrastructure specifically designed for use by pedestrians or bicyclists: they must "share the road" with motorized traffic.' The policy recognizes walking and bicycling as non-polluting, sustainable, environmentally friendly and healthy transport options and the promotion of these modes is part of its environmental policy. 'Walking and bicycling are healthy, sustainable, economical and non-polluting means of transport: the citizens of Uganda have the right to walk and cycle in safety, while conforming to appropriate regulations, in their pursuit of work and family tasks and in accessing social and economic activities and services,' states the policy.

Objectives: The primary objectives of the NMT Policy are to increase the recognition of walking and cycling in transport, planning, design and infrastructure provision; provide safe infrastructure for pedestrians and cyclists; mainstream resources for walking and cycling in agencies' financial planning; develop and adopt universal design standards that provide for access to all sectors of the community; and improve regulation and enforcement to enhance safety for pedestrians and cyclists.

The policy also acknowledges the importance of using universal design principles for all new and refurbished transport infrastructures and requires all urban road designs to include a NMT statement explaining how the needs of pedestrians and cyclists have been incorporated. It also makes note of the fact of very little monitoring or assessment of existing facilities for bicyclists and pedestrians. It categorically states, 'Even recently installed NMT infrastructure such as pedestrian crossings on highways have been incorrectly located, but the existing monitoring and evaluation processes have not identified these.' It recommended establishment of a National Road Safety Authority (NRSA) responsible for road safety, management and coordination.

The policy recognizes the importance of bicycles which are used for travelling to work and markets, running businesses and transporting water and produce in Uganda. It states, 'Government intends that the formal and informal private sectors should ensure that bicycles of designs suitable for the various users are readily available and affordable and that the supply, distribution and maintenance markets are sustainable.' It further adds, 'Government will encourage the private sector (including bicycle suppliers and commercial enterprises that advertise and sponsor) to develop innovative and imaginative ways of increasing the safety features on bicycles.'

Intervention: Some of the interventions include the Road Safety Policy developed by the government to promote the safety of pedestrians and NMT through the National Road Safety Council; government promoting construction of new NMT infrastructure, including footways, cycleways and cycle lanes, particularly in areas of high risk to pedestrians and bicyclists and government undertaking major investment programmes aimed at improving the physical infrastructure of Uganda's roads, cities and urban centres.

Challenges: Though the regulatory framework to facilitate and protect pedestrians and bicyclists is in place, weak enforcement or lack of compliance is the problem. Some urban roads have no footways and pedestrians are forced to share the road with traffic. Footways where present are frequently occupied by the traders who own shops, by other sellers on the pavement and parked cars.[129]

Steps are also being taken to decongest Kampala. According to the Multi-Modal Transport Master plan for Greater Kampala, over 2.5 million NMT trips are performed daily in the metropolitan area. By 2040, these daily NMT trips are expected to increase to eight million. Walking and cycling are also very important for rural people to access water, fuel, wood, fields and livestock, education, health, and work.[130] The Kampala Capital City Authority (KCCA) is implementing a NMT pilot corridor stretching from Bakuli traffic lights to Entebbe road, one of the busiest roads in the CBD.[131] This involves complete remodelling of a 2-km stretch of road that cuts through the centre of the city. The 'pedestrian shopping street' on the Namirembe road and old Luwum Street is redesigned into a car-less space with walking paths to encourage walking.[132] The KCCA had completed the first comprehensive, integrated and clearly demarcated walking and cycling corridor covering about 3.5 km.[133]

Nairobi

Nairobi NMT policy: Majority of people walk, cycle and use public transport modes (mainly matatus) in Nairobi. According to a modal split estimate, 84.5 per cent of the trips are on foot, matatus, buses, institution buses, cycles and trains. Only 15.3 per cent use private cars and other modes. Nearly 47 per cent trips are made on foot as majority of commuters cannot afford the expensive fare in other transport modes. It is a common sight in Nairobi to see people walking long distances and especially along the informal settlement areas and industrial areas. Another estimate from the Integrated Urban Development Master Plan for the City of Nairobi (NIUPLAN) 2015 also informs of high share of trips made on sustainable transport modes. Of the 6.8 million daily trips, 40 per cent walk, 40

per cent use bus or matatu, 13 per cent use private cars and remaining 7 per cent use other modes.

It is notable that the Nairobi City County has adopted a NMT policy which aims to develop and maintain a transport system that fully integrates NMT as part of the Nairobi transport system. The policy earmarks 20 per cent of their road construction budget to NMT investment. This policy will help in creating a safe, cohesive and comfortable network of footpaths, cycling lanes and tracks, green areas, other support amenities, and also laws and regulations to ensure that NMT facilities and areas are not encroached upon by the motorized modes and other street users.[134]

Table 10: NMT policy outcomes

Objective	Output	Outcome
1. Increase mobility and accessibility	Safe and cohesive pedestrian facilities (footpaths, etc) from 500 km to 1,500 km by 2020	Increased modal share of walking from 47 to 50 for trips up to 5 km by 2025
	Cohesive cycle network of lanes, tracks and destination facilities from 50 km to 1000 km by 2020	Increased modal share of cyclists from 2 per cent to 10 per cent for trips up to 15 km by 2025
	NMT facilities along and at major public transport routes and terminals from 500 to 1500 km by 2020	Increased modal share of public transport from 32 to 35 for all trips by 2025
	Nairobi Streets and Roads Design Manual (NSRDM) is to be developed by 2017	All roads within the country shall fully comply with the specifications of the NSRDM by 2025
2. Improve transport safety and security	Safe NMT crossings: Pedestrian signals from 185 to 500 Footbridges and underpasses from 27 to 50 Marked and visible crossings from 150 to 500 by 2020 Working street lights from 30,000 to 65,000 by 2020	Reduced pedestrian fatalities from 500 to 50 or less by 2025 Reduced cyclist fatalities from 20 to 5 by 2025
3. Improve amenities for NMT	No. of benches, no. of repair shops; no. of stores, etc.	Level of Service (LOS) rating of streets improves from D to B by 2025
4. Increase recognition and image of NMT in Nairobi	Percentage of road users considering NMT as a mode for the poor reduces by 40 per cent by 2020	Diverse income groups using NMT as mode of choice

Source: Anon 2015, Non-motorized transport policy, Nairobi City County Government

The policy proposes a range of measures including lower road speeds, new infrastructure and traffic calming measures, as well as awareness raising activity, enforcement and financial commitments. It commits 20 per cent of existing and future transport budget to walking, cycling and public transport infrastructure and services.[135]

Implementation

- According to the Nairobi City County Government, about 18.2 per cent of their annual road construction budget (558 million KSh) is for NMT infrastructure and facilities. This is an important step towards their 20 per cent target.
- The Ministry of Transport also re-affirmed the mandatory inclusion of NMT facilities for all new road construction. There was a recommendation to upscale the NMT policy to a national level, a suggestion now being taken into consideration by the Kenyan Ministry of Transport.[136]
- NMT works are underway at Kenyatta Avenue, Wabera and Muindi Mbingu streets coordinated by the county.
- The Nairobi Metropolitan Service (NMS) is implementing the Nairobi Mobility Plan and laying of kerbstones and blocks. This is progressing with ongoing roads and drainage work. Phase one runs along the Nairobi River from Donholm to Westlands to Eastlands and allows residents to walk or cycle into the CBD, Industrial Area and Westlands. Phase two will join phase one at the city centre and connects Lang'ata via railway city. Phase three will start from the CBD to Ngara and goes all the way to Roysambu.[137]
- Contract works along Kenyatta Avenue include the construction of pedestrian walkways and cycle track through developing an efficient non-motorized transport facility.
- In downtown, NMS is recarpeting Kirinyaga Road with asphalt concrete overlay. Grogan Road is also undergoing complete rehabilitation and hand-packing for construction of road base.
- Park road public transport facility is also undergoing a complete rehabilitation of drainage and construction of culverts along the drains.
- Along the New Pumwani Road, there is marking of loading zones and maintenance of road furniture.
- In Muindi Mbingu street, NMS is painting the paving slabs on the median along the street and also doing some maintenance of the road furniture. In Ruai Ward, there are the grading and opening up of access roads within the Kamulu estate.[138]

It is noteworthy that despite the pandemic, Nairobi improved NMT infrastructure. With the Nairobi Metropolitan Services (NMS) that came up after the change in governance, walking and cycling infrastructure in the CBD was improved. There are plans to extend this work to nearby neighbourhoods in line with the NMT policy.[139] On-street parking lots have been replaced by pedestrian walkways and cycling lanes. The number of pedestrians has increased and is nearly 20 to 40 times that of motorists along the Kenyatta Avenue. The refurbished Ngong Road now integrates pedestrian walkways and cycle lanes. The NMS in its first 100 days planned to complete renovations along Moi Avenue, Muindi Mbingu Street, City Hall Way and the University way, and later connect the city with Jogoo Road, Kibra, Westlands and Industrial Area. This NMT project will be later integrated with the upcoming BRT system.[140]

NMS has constructed 20 km of NMT infrastructure in Nairobi over the last one year. A number of vehicle parking spaces have been eliminated to create more and wider walking spaces.

Retrofitting change in UN Avenue, Nairobi, Kenya: UN Avenue is located in north sub-region of Gigiri in Nairobi County. The road, approximately 2.2 km in length, starts at the Limuru road junction and ends at Runda roundabout. Gigiri is a low-density and high-income urban residential area. It is also densely populated with foreign embassies and other international institutions, including the United Nations offices. The redesigned UN Avenue includes three-metre wide sidewalk on both sides, and a three-metre two-way segregated cycle lane. The intersection in Limuru road was redesigned adding a slip-turn lane with a corner island to facilitate pedestrian crossing. Bus stops were also relocated a few meters away to avoid conflict with turning vehicles and reduce accidents.

This now requires to be scaled up city-wide to have an extensive network of walking and cycling paths.

KENYA—URBAN MOBILITY AND CLEAN TRANSPORTATION POLICIES

Martin Eshiwani, Director, Ministry of Transport and Infrastructure, Kenya and at present with Nairobi Metropolitan Services

Our move towards cleaner air is backed by clear policy documents. These policy documents include Article 42 of Kenyan's constitution (2010) that provides for right to clean and healthy environment to current and future generations. Secondly, we have Climate Change Act 2010 that provides for enhanced response to climate change and measures to achieve low carbon climate resilient development. Third, we have the National Climate Change Action Plan (NCCAP) 2018–2022 which provides a framework to Kenya to deliver on its Nationally Determined Contribution (NDC).

Transport sector is the main contributor to air pollution in Nairobi city. The sector is currently characterised by traffic congestion, poor quality of public transport and air pollution from vehicles. Though overall motorization is low, the rapid rate of motorization is of concern. In Kenya, an average of 90,000 vehicles are registered annually, about 50 per cent of them are in and around Nairobi. About 105,000 units of motorcycles are being registered annually. The rapid growth is likely to worsen the congestion and pollution in the city.

Measures have been taken to address air quality including Integrated National Transport Policy, Nairobi Integrated Urban Development Plan, Urban Mobility Plan and Nairobi Transport Act that advocates for integrated mass transit system, low emissions and e-mobility. For mass transit systems (MTS) we are looking at development of BRT whereby we have already identified five corridors and line one and two are under construction. We want the MRTS to be the most preferred mode of transport and attract private car users to reduce use of private cars. Part of our effort has been to improve commuter rail both in terms of infrastructure as well as rolling stock. People taking trains to the airport are able to get real time information of the flights at Jomo Kenyatta international airport. SGR trains in Nairobi provide services to Mombasa. They have significantly reduced the number of buses that come to the city of Nairobi. On an average, trains carry about 4 million passengers per day between the two cities.

Another area that has drawn a lot of attention and effort is Nairobi Metropolitan Services. The Nairobi City County government and road authorities have prioritized development of NMT infrastructure. About 48.2 per cent of people in Nairobi walk or cycle to places of work, business or to access social amenities. NMS has constructed 20 km of NMT infrastructure in Nairobi over the last one year. The existence of well-developed NMT infrastructure in Nairobi provided considerable benefits during COVID pandemic because it allowed physical distance. We have also eliminated a number of vehicle parking spaces to create more and wider walking spaces.

Another area we have embarked on is electric mobility. Electric mobility is being promoted as part of improving air quality. More than 70 per cent of the energy in Kenya is from renewable sources—geothermal, hydro and solar. So, we take pride in that and we continue to invest heavily in geothermal and solar installations and are able to move towards 100 per cent green energy in the next 20 or so years.

With regard to electric mobility, Kenya has already developed standards for use in electric motor vehicles/cycles that we have developed with support from UNEP and GIZ. The Kenya government in the 2019–20 budget reduced the excise duty and is also considering other incentives to promote uptake of electric vehicles. Nairobi Transport Act 2020 passed by the Nairobi County provides for creation of low emission zones whereby no fuel-based vehicle will access the zones from 2035. Nairobi currently has over 200 electric vehicles and projected target is to reach 250,000 vehicles by 2025. We are implementing BRT line 2 to use low emission buses while line 3 will use 100 per cent electric buses.

E-bikes are being piloted both in Nairobi and Kisumu, 350 km away from the former. The idea is to use this pilot to generate data that can be used to promote use of electric bikes among motorcycle riders in the country, particularly those using them for public transport services.

Nairobi Transport Act (2020) requires all new public buildings to have charging stations. It promotes car parks with charging infrastructure facilities. We are currently developing a framework to allow the private sector to install charging infrastructure at public places. Kenya Power, the company which supplies electric power in the country is in discussions with quite a number of stakeholders. It has pledged to construct charging infrastructure in key cities and along the major highways. Most of these vehicles have a range of about 300 km.

Intelligent Traffic Management System (ITS) is yet another initiative to manage and improve traffic so that there is optimum utilization of the road infrastructure and reduced traffic congestion. It will adjust traffic signal timings, optimize road network performance, give priority to BRT once in operation, collect and manage data, and provide real-time inter-modal travel information to enable travellers to make an informed choice.

In addition, an expressway is being developed to link the Jomo Kenyatta international airport and other places and will significantly reduce the congestion together with the MRTS, BRT and the commuter train.

Excerpt from the Pan Africa Network meeting organized by CSE on 21 October 2021

Chapter 11: Vehicle restraint measures in Africa

Why Africa has the opportunity to reduce use of automobiles in the early stages of growth?

Even though overall vehicle stock in most countries is still small, growth rate has picked up. Major cities are in the grip of crippling congestion that increases toxic exposure and fuel guzzling. The ideas of adopting vehicle restraint measures in terms of recovering true cost of owning and using personal vehicles through pollution and congestion taxes, or designing demand management measures like parking restraints and pricing or adopting low emissions and car-free zones to reduce dependence on personal vehicles at the early stages of motorization are still very nebulous.

It is encouraging to see that there are hints of such measures across several countries, even though very few and limited in scope. There is considerable scope for expanding such measures, especially in view of the fact that dependency on personal cars is still very low and most people are walking and using public transport. This is an opportunity to modernize these systems while promoting restraint measures and well-designed car-free public spaces. Otherwise, rapid motorization can lock in enormous pollution, energy intensity and carbon in the long run.

Nairobi

Pay and park in Nairobi: Nairobi has taken the lead to introduce priced parking to reduce demand for parking and car usage. This step towards designing parking policy as a demand restraint measure is an important policy instrument to contain motorization. Parking demand is insatiable and infinite. The number of vehicles that are registered in Nairobi annually can create additional demand for land areas as big as 100 football fields. This takes away land from more important services including affordable housing, health care centres and educational institutes. Cheap and free parking is a subsidy to rich car owners and loss to the local government exchequer.

The costs of using valuable urban land for parking of personal vehicles are not recovered through proper taxes and pricing. Parking rates, even in expensive

parking structures, are minimal and are not adequate to recover the cost of investment. This is a subsidy. This subsidy amount will work out to be much larger if the rental or the land cost is taken into account. Increased investment in expensive and prime areas of the city further enhances this subsidy as the parking rates are not expected to recover this cost.

Parking in Nairobi was earlier managed by the Nairobi City County with 13,000 on-street and 460 off-street (mainly in the CBD area) parking lots. Entire Nairobi has priced parking though unauthorized parking lots also coexist. Parking charges vary—cars have to pay 300 KSh for an entire day in an on-street parking whereas in case of off-street parking, it is 50 KSh for entry and thereafter 30 KSh every 30 minutes. This comes to 12.5 KSh every hour in case of on-street parking and 110 KSh for an hour in an off-street parking lot. Nairobi City County also initiated a pilot project of cashless parking pricing system for paying parking charges through phone. In case of failure to pay, cars are clamped and a penalty of 2000 KSh charged to be paid within 2 hours of clamping the vehicle. Thereafter, the car is towed and impounded for which the car owner has to shell out 2500 KSh for towing and 3500 KSh for impounding. There were plans to go for hourly charging but these were dropped. Parking charges were revised to KSh 200 for both on-street and off-street parking in and outside of CBD.

While these are important steps forward, Nairobi needs a cohesive parking policy and parking management area plans for each municipal ward and neighbourhood that can comprehensively identify legal parking areas and demarcate them on ground for proper management, prevent and penalize illegal parking, enforce variable parking pricing, prevent parking in green areas and on footpaths, and enable creation of dedicated fund from parking revenue for local area improvement.

Kigali, Rwanda

Car-free days and car-free zones in Kigali, Rwanda: Kigali is the capital city of Rwanda and known as one of the cleanest and safest cities in Africa. Gasabo, Kicukiro and Nyarugenge are the three districts consisting of 35 sectors, 161 cells and 1,183 *Imidugudu* (villages) in the city.[141] In 2017, air pollution was the second leading risk factor for more than 8 per cent of premature deaths in Rwanda. Road traffic along with other sources contributes to air pollution.

Kigali is the first city in Africa to initiate car-free days. It was initiated in 2016 as part of the City of Kigali initiative. Started as a monthly car-free day in 2016, it was made bi-monthly after the President's visit and recommendation in 2017.[142]

It is celebrated on the first and third Sundays of every month. On this day, vehicle movement is restricted in certain parts of the city to encourage people to walk, jog or cycle.

Car-free zones include KN 4 Ave, KN 78 St and KN 84 St.[143] Vehicles are prohibited to ply for four hours and children and adults can be seen jogging, cycling, strolling and exercising in designated areas in Kigali.[144] Medical services such as check-ups, eye and dental care, etc. are also offered free. Nearly 7,000 people every year are estimated to avail these services. Over 20,000 people are estimated to participate in car-free day activities.[145] In 2019, three more car-free day sites were added.

The city of Kigali has put in infrastructure (toilets, police post, WIFI, public seating, sockets, water source, first-aid, signage, garbage points, lost and found station, cleaning/maintenance, parking, shade, decorative and functional lights) in place and done zoning (food—eateries, bars, cafes, small shops; events—poetry, live music, street festivals, concerts, fitness; exhibitions—movie screenings, art, technology and IT hub) for the car-free days and car-free zones.[146]

The objective was to prevent non-communicable diseases. It was therefore designed around mass sports activities, family gatherings outdoors and reduction in transport emissions on those particular days.[147] This initiative helps to make people aware and conscious of a healthier lifestyle and encourages green commuting. Studies have shown nearly 50 per cent reduction in $PM_{2.5}$ and PM_{10} is possible near car-free roads on car-free days.[148] A team led by R. Subramanian of the Center for Atmospheric Particle Studies (CAPS) and Paulina Jaramillo of Engineering and Public Policy (EPP) used real-time affordable multi-pollutant (RAMP) monitors and found car-free days to reduce ambient air pollution, particularly $PM_{2.5}$ and black carbon.[149]

The Kigali city administration had put in a lot of effort to get a buy-in for this initiative and making it successful. It included continued mobilization and dialogue with residents; working very closely with different stakeholders—business community, public transporters and the civil society—and also working closely with the police to reduce traffic disruptions by providing alternative routes for vehicles. [150]

There are plans to expand this initiative to other parts of Kigali as well.

Kampala, Uganda

Car-free day in Kampala: Car-free day in Uganda has adopted the theme of, 'I am the solution to pollution and traffic in my city.' This initiative aims to advocate against the danger of over-relying on cars as major means of transport in Ugandan cities such as Kampala and Jinja. Several major arteries are closed down for cars on car-free days. This has resulted in lowering of overall traffic on this day compared to the other days of the month.[151]

Four car-free days have been organized in Uganda. The first one was in 2011 in Kampala, followed by one again in Kampala in 2012, Soroti in 2014 and Kampala again in 2019. Selected streets were closed off for half a day on these car-free days allowing the public to experience their street space. All these were coordinated by the Uganda Sustainable Transport (UST) Network.[152]

Addis Ababa, Ethiopia

Car-free day in Ethiopia: 'Menged Le Sew' (Streets for People) is a government backed monthly car-free day which originally started in Addis Ababa and is extending to other cities.[153] While the first car-free day was launched in December 2018, the second one was held on 13 January 2019 under Ministry of Health initiative. People in Addis Ababa, Dire Dawa, Bahir Dar, Hawassa, Adama, Jimma, Mekelle and Jigiga joined the event. During the car-free days, people jog and cycle in the Addis Ababa city centre.[154] The initiative is led by the Ministry of Transport and regional governments with support from partners.

Lamu, Kenya and Fes-al-Bali, Morocco

Car-free towns: The coastal town of Lamu in Kenya is an UNESCO World Heritage site. It is a car-free island and among the oldest and best-preserved Swahili settlements in East Africa. In order to preserve its heritage and architecture, only pedestrians, bicycles, and donkey carts are permitted on the narrow streets of the old town.

Fes-al-Bali in Morocco is also a UNESCO World Heritage site and a car-free urban area. People get around the place on foot, donkey or cart as the streets have narrow alleyways.[155]

Chapter 12: Sign post

There are positive signs of change in Africa today. They collectively point to the direction of change and also lay the foundation for future change. The question is how soon will it see the big turn around? Given the enormity of the air pollution challenge, this transition needs scale and speed to maximize the co-benefits of public health and climate change mitigation.

Mitigation requires local, national and regional level coordination for harmonized action. More synergy in action is needed to expand air quality monitoring and pollution source assessment, and common but more stringent emissions standards and fuel quality norms that are also linked with the vehicle import policy to integrate the market. Countries need to approach innovative taxation and pricing policy based on differentiated principle and polluter pay principle to fund the transition to cleaner fuels and technologies, and adopt policy guidelines, mandates and targets to scale up public transport, walking and cycling. Vehicle restraint measures are also needed for the mobility transition.

This region also has an opportunity to leapfrog to zero emissions electric mobility and avoid the pollution and energy intensive pathways of internal combustion engines.

This compendium of action is an evolving initiative of the Pan Africa Network on Clean Air Solutions. As more information and knowledge is mobilized through the network participants, this compendium will be more enriched. It is hoped that the process of cross learning and further strengthening of local action across the region will help to track progress and build confidence in change.

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As the Global South battles toxic air pollution and the effects of climate change, there is considerable interest in understanding how countries in Africa are preparing to take on these challenges. What is the direction and scale of change? What can countries in Africa learn from each other and other countries in the Global South? To answer these questions, this rapid documentation has been carried out based on the latest information available on the emerging good practices in the region.

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