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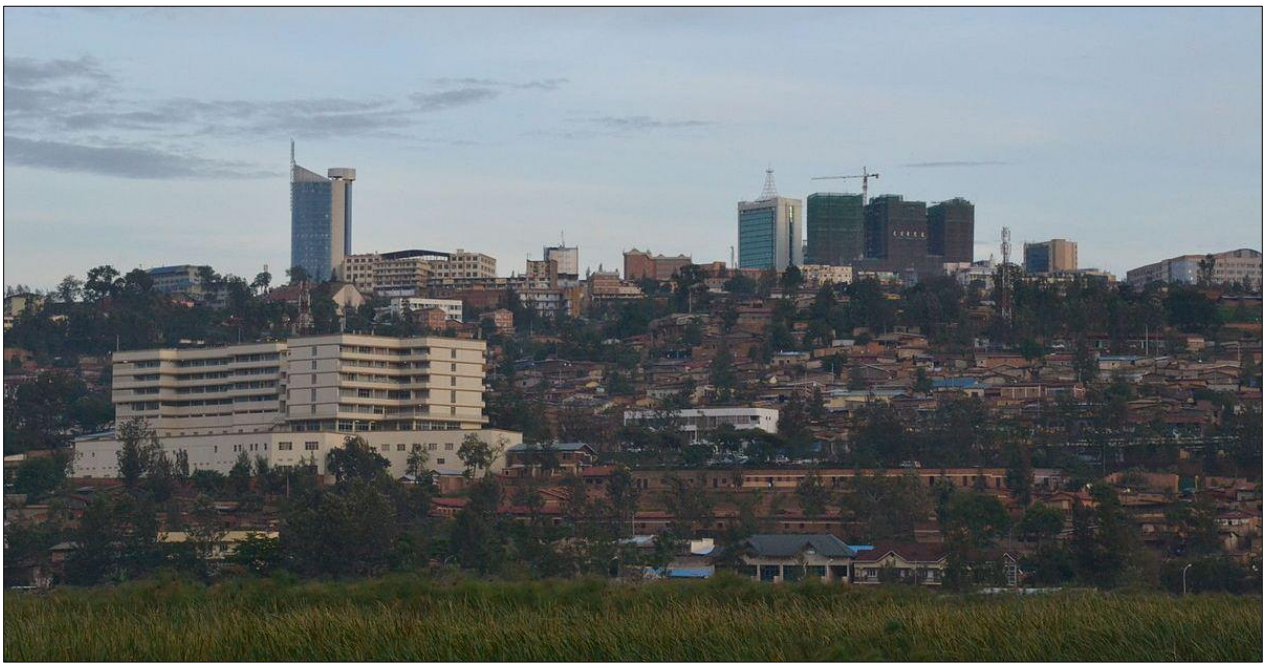
Kigali City Air Quality Policy and Regulatory Situational Analysis



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ECI ENVIRONMENTAL COMPLIANCE INSTITUTE

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION I

1.0 INTRODUCTION

This section provides the overall background to the project as well as general background information about the City of Kigali.

1.1 Overview of the Project

The Kigali City Air Quality Policy and Regulatory Situational Analysis has been conducted as part of a pilot project led by UN Environment to support three African cities – Addis Ababa, Kigali and Nairobi – to develop better air quality management strategies. The overall objective of the project is to build the capacity of relevant national and city officials to develop, implement and enforce better policy and regulatory frameworks for air quality management and support the development of strategies for air quality management in these cities. Specifically, the project seeks to:

- generate knowledge and raise awareness on air quality;
- develop tools and methodologies to better address air quality issues in Addis Ababa, Kigali and Nairobi according to the their unique situations and air pollution apportionment;
- Provide policy recommendations on sectoral solutions that bring air quality co-benefits as well as recommendations on effective implementation, enforcement and/or compliance with policy and regulatory framework.

1.2 Purpose and Scope of the Situational Analysis

The purpose of this situational analysis is to obtain a better understanding of the governance framework for air quality management in Kigali City (policy, legislative and regulatory mechanisms, including compliance and enforcement), with a view to outlining existing and/or apparent gaps and proposing recommendations to address the same.

The analysis covers all relevant sectoral national policies, strategies, laws and regulatory mechanisms – including standards, Prime Ministerial Instructions, Ministerial Orders, Implementation mechanisms and infrastructure. The analysis was carried out between April and July 2018.

1.3 Methods

This situational analysis was conducted using desktop review, key informant interviews and field observation as described in more detail below:

i) Desk top review

Several policy, legislative and regulatory instruments/documents were reviewed and analysed: These included: the Constitution of Rwanda; Vision 2020 and the Economic and Poverty Reduction Strategy II; relevant sectoral policies laws, Instructions, Orders and Standards; several publications including books, reports, journals, and official government websites.

ii) Key informant interviews

The key informant interviews were semi-structured in nature and consisted of a series of questions designed to elicit specific answers on the part of key informants in selected Rwanda governmental agencies that have some role relevant to air pollution abatement in Kigali City. These institutions interviewed included: Ministry of Environment, Ministry of Infrastructure, Rwanda Environment Management Authority, Rwanda Revenue Authority, Rwanda Standards Board and Rwanda National Police (Motor Vehicle Inspection Centre).

iii) Field observation

One field visit was conducted at the Motor Vehicle Inspection Centre in Remera, Kigali with the objective of not only interviewing the Centre's management but also observing the nature, capability and capacity of the existing testing infrastructure for motor vehicle emissions.

1.4 Kigali City Background Information

1.4.1 Location Size and Administrative structure

Kigali is the capital city of Rwanda and is geographically located almost at the center of the country on latitude 1^0 57' South and longitude 30^0 04' East. It is the largest city in Rwanda and the country's economic, cultural and transport hub, and is recognised as one of the cleanest, greenest and safest cities in Africa[1]. The city covers an area of 730 km^2 of which 30% is urban (built up) area and 70% rural area. Kigali City consists of three districts namely: Gasabo, Kicukiro and Nyarugenge. The districts are further divided into 35 sectors, 161 cells and 1183 Imidugudu (villages)[2].

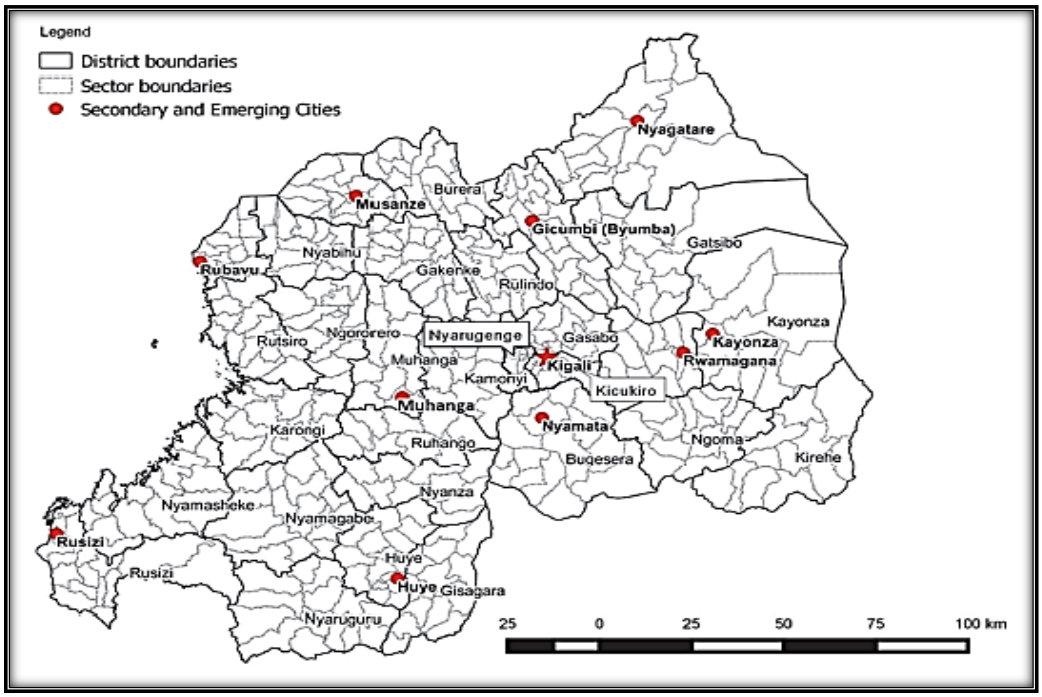
[1] *Lasale J.L., Kigali City Report, 2016*
[2] *City of Kigali official website, accessed on 17.07.2018*

The administrative structure of Kigali City comprises of:

a) The Council of the City of Kigali – composed of 33 members elected or nominated according to the Law. The Council is responsible for, *inter alia*, making decisions, developing strategies and issuing instructions with respect to development policies for the City of Kigali, approving guidelines, regulations, master plans, budgets, rates charges, procurement and disposal of immovable property, etc.
b) The Executive Committee – comprised of the Mayor and two Vice-Mayors. The Committee is responsible for, *inter alia*, implementation of Government policies, monitoring the implementation of decisions and regulations of the Council of the City of Kigali, and disseminating laws, regulations and decisions of the Council of the City of Kigali and those of the Government to ensure their implementation.
c) The Executive Secretariat – led by the Executive Secretary of the City of Kigali and is responsible for, inter alia, managing the staff members of the City of Kigali, developing and implementing the action plan of the City of Kigali; and, coordinating the planning of activities of the City of Kigali and its districts.
d) The Security Committee- oversees overall public security affairs within Kigali City.

Figure 1 below is a map showing Rwanda's administrative boundaries and the position of Kigali and other secondary and emerging cities.

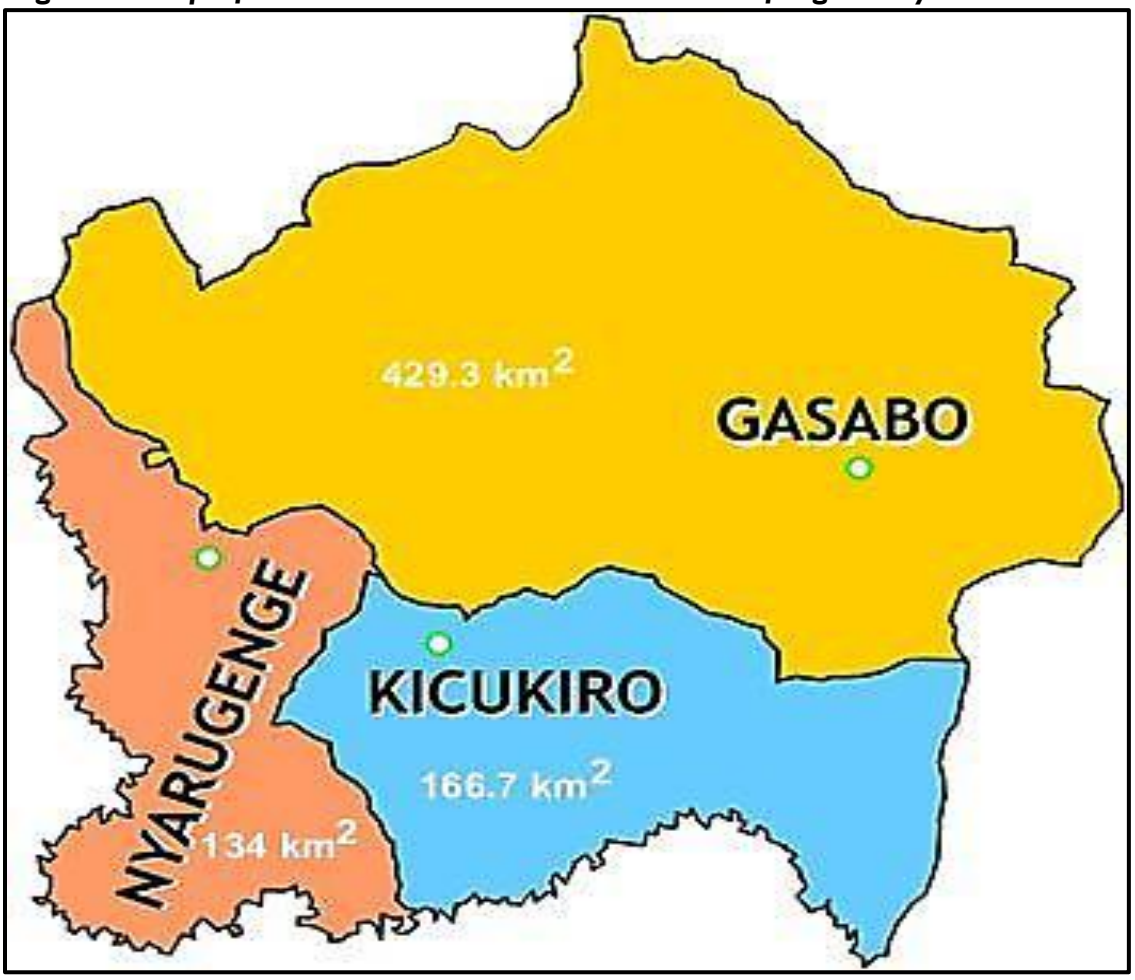
Figure 1: Map of Rwanda administrative boundaries



Source: World Bank Group, 2017

Figure 2 below shows the administrative boundaries and size of Kigali City's 3 districts

Figure 2: Map of administrative boundaries and size of Kigali City's 3 districts



Source: City of Kigali, 2018

1.4.2 Population

Kigali City's population is estimated to be about 1.2 million people as of 2017. The city's population growth rate is 6.2 per cent per annum compared to 2.8 percent for the rest of the country. Kigali is one of the most densely populated cities in Africa with a population density of 1,644 people per square kilometre[3]. Males comprise 53% of the population while females comprise the remaining 47%. The City's population is mainly young with 57% of the population being between the age group of 15-65 years of age, while 40% percent of the population is under the age of 15 years with only 3 per cent being above 65 years. Kigali

[3] *World Bank Group, 2017*

City's population represents 10% of the national population[4], which currently stands at about 12 million. Kigali's population is projected to grow to 2.5 million by 2025 and 4.3 million by 2040[5].

1.4.3 Climate and Topography

Rwanda generally has a temperate tropical highland climate that is also reflected in Kigali City. Kigali has a typical daily temperature range between 12 °C and 27 °C with little variation through the year. Like most parts of the country, Kigali has two rainy seasons, one between March – May and the other around October – December. The annual average rainfall is 800mm[6].

The topography of the Kigali city is generally a hilly landscape sprawling across ridges and wetlands with an altitude varying between 1300-2100m. The Nyarugenge District is dominated by a strong linear ridge running north-south with a maximum altitude of 1900m and softens towards the flat alluvial planes of the Nyabarongo River on the west. The Gasabo District constitutes more aggressive relief due to the tight rectilinear ridges oriented northwest with a maximum altitude of 2100m to 1900m and gentle relief along the Nyabugogo River and southern part of the district. The Kicukiro District is composed of gentle slope plateaus, averaging less than 1700m of altitude and the slopes gently settle into the alluvial plains of the Nyabarongo River[7].

1.4.4 Land use distribution

Due to the hilly nature of Kigali's terrain, almost 83% of the city's land area is natural unplanned areas and rural agrarian land. Urban land uses such as residential, commercial, industries, and social and infrastructure facilities occupy only about 17% of the city's total land area. The urban area of Kigali City is mainly concentrated around the Central Business District at Nyarugenge with some spread along the east-west highway towards the Kigali International Airport in the east. The new growth areas are mainly developing along major transport corridors in the city[8].

Table1 below shows the current land use distribution in Kigali City.

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[4] National Institute of Statistics of Rwanda, Fourth Population and Census Report, 2012
[5] Socio-Economic Study for Kigali 2010-2040
[6] Ibid
[7] Kigali City-Analysis, Bench Marking, and Vision Report ,2013
[8] Ibid

Table 1: Land use distribution in Kigali City

Land Use Types	Area in Km²	Percent
Residential	67.58	9.2
Commercial	2.85	0.4
Mixed Use	0.22	0.00
Public facilities	13.74	1.9
Industries	4.41	0.61
Nature Area	141.98	19.4
Open Space	2.171	0.3
Agriculture	461.37	63.1
Water Bodies	2.905	0.4
Infrastructure/Roads	20.84	2.8
Special Use	13.46	1.8
Total Area	731.53	100

Source: City of Kigali, 2013

1.4.5 Socio-economic situation

Kigali City contributes about RWF 1,266 billion (around US$ 2.1 billion) which is approximately 41.0% share of Rwanda's GDP. The Services sector account for 62% of Kigali's GDP with agriculture accounting for just 5.5% of Kigali's GDP[9] .According to the City Development Plan (2013-2018) report ,the city poverty level was revised (% under poverty line) setting a target of 20% though the average poverty level in the City is 14.8%. Various programs were proposed under the social protection sector to reduce extreme poverty in the City. The report showed that the relocation of people living in informal settlements and high risk areas posed a great risk to poverty reduction. The women and unemployed youth in the City also increased poverty levels within the City. Establishment of 17 programs that targeted these groups in the City would boost their productivity and income generation and help to address poverty in the City

[9] *Ibid*

and achieve the revised target of 20% and less than 10% for the City of Kigali[10]. Kigali's GDP is projected to be RWF 21,284 Billion by 2040 with the services sector representing 62.9% of this GDP share. The total workforce of Kigali in 2040 is estimated to be 2.33 million. It is also estimated that the services sector will create 1.63 million employment opportunities by 2015[11].

1.4.6 Transport and Infrastructure

The City of Kigali is challenged by a rapid increase in motor vehicles congestion on its roads especially during peak hours with resultant air pollution. This is a direct result of high population growth and an exponential increase in private car ownership. However, there have been recent improvements in public transport services with high capacity buses and minibuses gradually gaining prominence besides the motor cycle taxis (moto-taxi). Road infrastructure has also greatly improved with most roads in the city now paved. These developments have also factored in non-motorized transport infrastructure such as pedestrian walk ways and bicycle lanes, as well as car free zones within the city centre.

1.4.7 Energy Situation

The Economic Development and Poverty Reduction Strategy (EDPRS II) targets at least 563MW installed power generation capacity in Rwanda by the end of 2018. In this regard, Rwanda Energy Group (REG) targets to connect all Rwandan households to electricity by 2024[12]. Currently, just about 35 per cent of the national population is connected, but this figure is higher in urban centres and cities such as Kigali. Households are currently the dominant consumers of electricity (51%), which is primarily used for lighting. The second largest consumer is the industrial sector (42%), which mainly comes from motor-drivers and lighting. Public sector consumption (6%) is largely due to public buildings, street lighting and water pumping. In terms of household cooking energy, 97% of all consumption comes from biomass energy resources, comprising firewood 86%; charcoal 11%; crop waste 2%; and other fuels 1%. In urban areas, electric stoves and microwaves are used to a limited extent. Commercial establishments and wealthier households are increasingly using Liquefied Petroleum Gas (LPG). Whereas it is projected that the balance of energy will shift in coming years due to a projected increase in demand for electricity, for the time being the main primary energy source in Rwanda will continue to be biomass, principally used in cooking[13].

[10] *Republic of Rwanda, City Development Plan (2013-2018)*
[11] *Ibid*
[12] *REG official website, accessed June 2018*
[13] *MININFRA, Sustainable Energy for All Rapid Assessment and Gap Analysis, 2014*

1.4.8 Waste management

Kigali City's landfill site located in Nyanza currently receives over 100 tons of waste every day. Previously, the facility lacked proper waste treatment technologies leading to poorly managed accumulation of waste at the site coupled with problems such as bad odour, methane gas explosions, air pollution, risks of garbage landslides and groundwater pollution. However, with technical and financial support from UNDP, the City of Kigali has been able to greatly improve the landfill facility and its maintenance techniques[14].

1.5 Why air pollution is a primary concern

Today, air pollution presents the greatest environmental health risk globally with many parts of the world recording dangerously high levels of air pollution. Updated World Health Organization (WHO) estimations show that 90 per cent of people worldwide breathe air containing high levels of pollutants. Air pollution causes 1 in every 9 deaths globally. The WHO estimations reveal an alarming death toll of 7 million people every year caused by exposure to fine particles in polluted air that penetrate deep into the lungs and cardiovascular system, causing diseases including stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and respiratory infections, including pneumonia. Of the total annual air pollution related deaths, 4.2 million result from exposure to ambient (outdoor) air pollution and 3.8 million from exposure to household air pollution in smoke from dirty cookstoves and fuels[15, 16,17].

Approximately 2,227 premature deaths were attributed to ambient air pollution in Rwanda in 2012 alone, out of which 1201 were male and 1026 female[18]. According to the WHO estimates, the highest level of annual concentration of $PM_{2.5}$ in Rwanda's cities including Kigali was 185 µg/m3 in 2014 which is way above the WHO limit of 10 µg/m3 for annual mean concentration[19]. 2018 WHO estimates attribute an average mortality rate of 59.1 deaths per 100,000 population in Rwanda to household and ambient air pollution.

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[14] *UNDP Rwanda official website, accessed June 2018*
[15] *WHO, Ambient (Outdoor) Air Quality and Health Fact Sheet, 2018*
[16] *WHO, Household Air Pollution and Health Fact Sheet, 2018*
[17] *According to the WHO, many people are exposed to both indoor and outdoor air pollution. Due to this overlap, mortality attributed to the two sources cannot simply be added together, hence the total estimate of around 7 million deaths annually.*
[18] *WHO, Ambient Air Pollution: A global Assessment of Exposure and Burden of Diseases Report, 2016*
[19] *Ibid*

Besides the adverse health impacts, some of the air pollutants have serious immediate and long term environmental effects. Air pollution negatively affects plant biodiversity and their attendant ecosystem services, destroys cultural heritage and contributes to global warming[20].

Table 2 below provides a summary of the key air pollutants that have significant health and environmental impacts.

Table 2: Air pollutants of great impact on health and environment

Emission	Description	Sources	Harmful Effects
Carbon monoxide (CO)	CO is a colourless, odourless toxic gas produced by incomplete or inefficient combustion of carbon-based fuels and by biological and industrial processes.	Anthropogenic Sources Fossil fuel combustion for power generation or transport, agricultural burning, wood burning for heat and cooking fuel Natural sources Forest fires, emissions from plants and oceans and oxidation of methane and non-methane hydrocarbons	Health impacts Can cause dizziness, confusion, unconsciousness and death
Nitrogen oxides (NO_x)	Nitrogen Oxides (NO_x) is a collective term for nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colourless and tasteless gas while NO_2 is a yellowish-orange to reddish-brown gas with a pungent, irritating odour and is a strong oxidant.	Anthropogenic Sources combustion of fossil fuels in vehicles (predominantly road traffic) and power generation units Natural Sources wildfires, lightning, and microbial activity in soils	Health Impacts • Eye and lung irritation • May contribute to the susceptibility/ aggravation of respiratory diseases Environmental impacts • Accelerates eutrophication • Makes soils and freshwater ecosystems more acidic • Affects visibility due to formation of haze in the air
Ozone (O_3)	Major urban air pollutant caused by NOx and VOCs combined In sunlight and is usually at Earth's surface (Tropospheric Ozone)	Secondary pollutant of VOCs and NOx	Health Impacts Respiratory and cardiovascular problems Environmental problems Affects sensitive vegetation and ecosystems such as forests, parks, wildlife refuges and wilderness areas
Sulphur dioxide (SO_2)	SO_2 is a colourless, non-flammable gas, with an unpleasant, pungent odour.	Anthropogenic Sources Fossil fuel combustion for power generation, industry, shipping and road transport Natural Sources Volcanoes	Health effects Affects the respiratory system and irritation of the eyes, nose, throat and airways Environmental impacts • Reduces growth in plants

[20] *Gurjar, B.R., et al., Air Pollution: Health and Environmental Impacts, CRC Press, Tylor & Francis Group, Boca Raton, 2010*

			• Accelerates loss of foliage, aging and premature death of vegetation • Causes stain and damage stone and other materials, including culturally important objects such as statues and monuments. • Can reduce visibility due to formation of haze in the air
Particulate matter (PM10, PM2.5)	Particulate matter (PM) refers to a mixture of solid particles and liquid droplets found in the air such as dust, dirt, soot, or smoke that are large or dark enough to be seen with the naked eye and can be primary or secondary. PM10 refers to particles with diameter less than 10µm and cannot be inhaled PM2.5 refers to fine inhalable particles with diameter less than 2.5µm	Anthropogenic Sources Combustion from vehicle engines, power plants, domestic heating and cooking, mining, quarrying and fugitive dust emissions from construction activities Natural Sources Erosion of natural materials, wind suspension of soils and constituents of sea spray	Health impacts Respiratory and cardiovascular problems (mainly associated with $PM_{2.5}$) Environmental impacts • Nitrogen and sulphur containing particles can lead to acidification of soils and water course • High levels of dust deposition onto vegetation can affect plant health and reduce growth • $PM_{2.5}$ particles can reduce visibility in cities

SECTION II

2.0 STATE OF AMBIENT AIR QUALITY IN KIGALI CITY

This section provides an overview of the state of ambient air quality and air quality monitoring in Kigali City. The section should be read in conjunction with the 2018 REMA study - Inventory of Sources of Air Pollution in Rwanda[21] - that has analysed in great detail the main sources of air pollution in Kigali City.

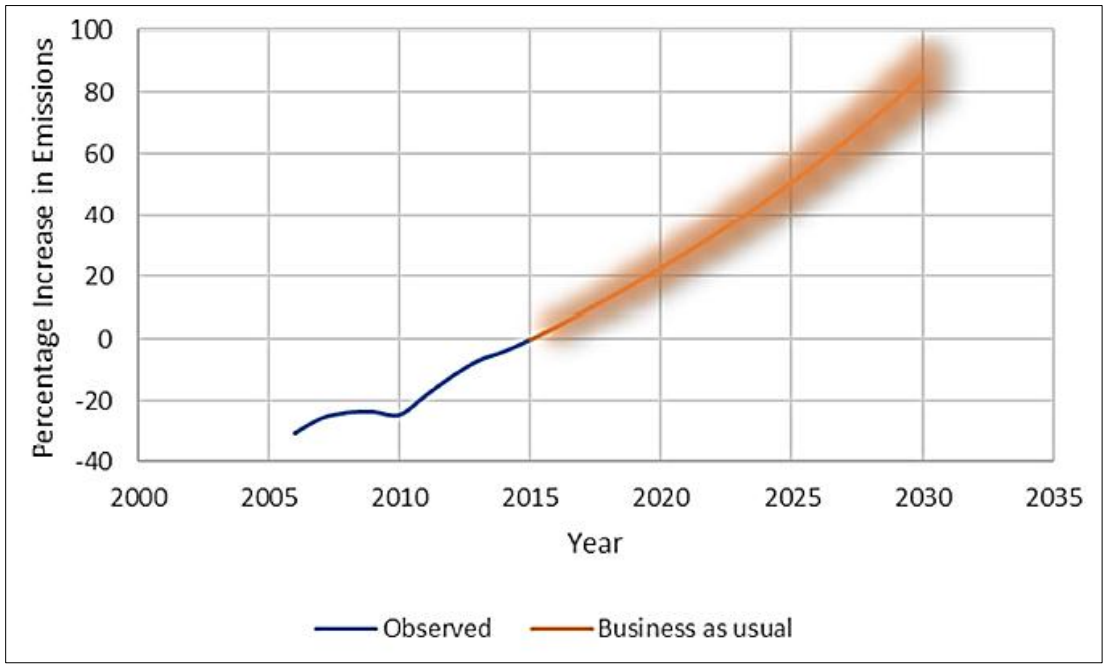
2.1 Current state of air quality in Kigali

Whereas the air quality in Kigali is fairly good compared to many cities in Sub-Saharan Africa, industrial activity, motor traffic density and human population continue to grow in the city hence the increasing concern about air pollution[22]. Recent studies shows that the levels of PM and NO_X in Kigali city are well above WHO guideline values. The elevated background concentrations of PM_{10} and $PM_{2.5}$ in Kigali City are mainly attributed to domestic stoves. On the other hand, high PM and NO_X levels close to busy roads in the city point to motor vehicles as the main source[23].

Just like the rest of Rwanda, Kigali city's air quality is expected to deteriorate in the near future as the country becomes more developed in terms of urbanization, industrialization and population explosion. It is anticipated that emissions from sectors such as energy generation, manufacturing, transportation and domestic sources would only exacerbate air pollution in Kigali city if no policy and regulatory interventions are put in place. The REMA study[24] has put forward an Air Quality Control Strategy to tackle the current as well as expected rise of air pollution not only in Kigali but also in other emerging cities in Rwanda. The study projects an increase in national emissions of up to 85 per cent by 2030 compared to 2015 levels under a Business as Usual (BAU) scenario (i.e. if the strategy is not implemented) and an increase of 50 per cent over the same period if the strategy is implemented (See Figures 3 and 4 below)[25].

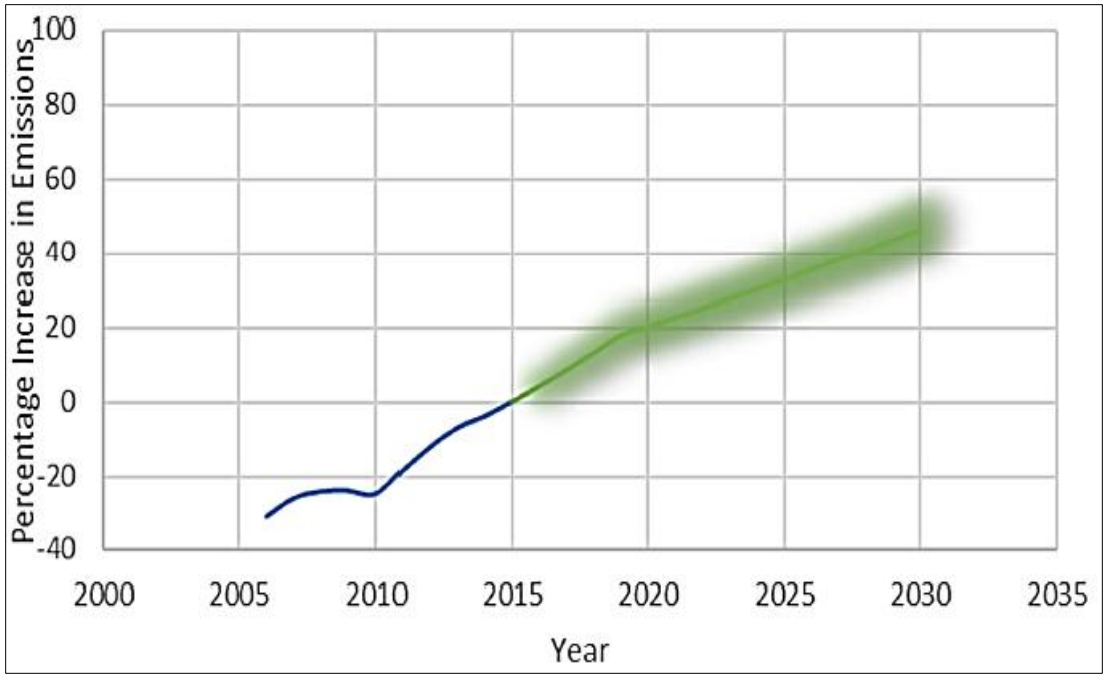
[21] *REMA, Inventory of Sources of Air Pollution in Rwanda: Determination of Future Trends and Development of a National Air Quality Control Strategy, 2018*
[22] *Nsengimana, et al., Study on Air Pollution in Rwanda with reference to Kigali City and Vehicular Emissions, 2011*
[23] *Ibid*
[24] *Ibid*
[25] *Ibid*

Figure 3: Trend of Rwanda emissions assuming BAU scenario



Source: REMA, 2018

Figure 4: Trend of Rwanda emissions following implementation of air quality strategy



Source: REMA, 2018

2.2 Key air pollutants of concern in Kigali City and their sources

Current baseline and historical air quality data for Kigali shows that the key pollutants of great concern for the city are:

i. Particulate Matter (PM_{10} and $PM_{2.5}$)
ii. Nitrogen (NO_2)

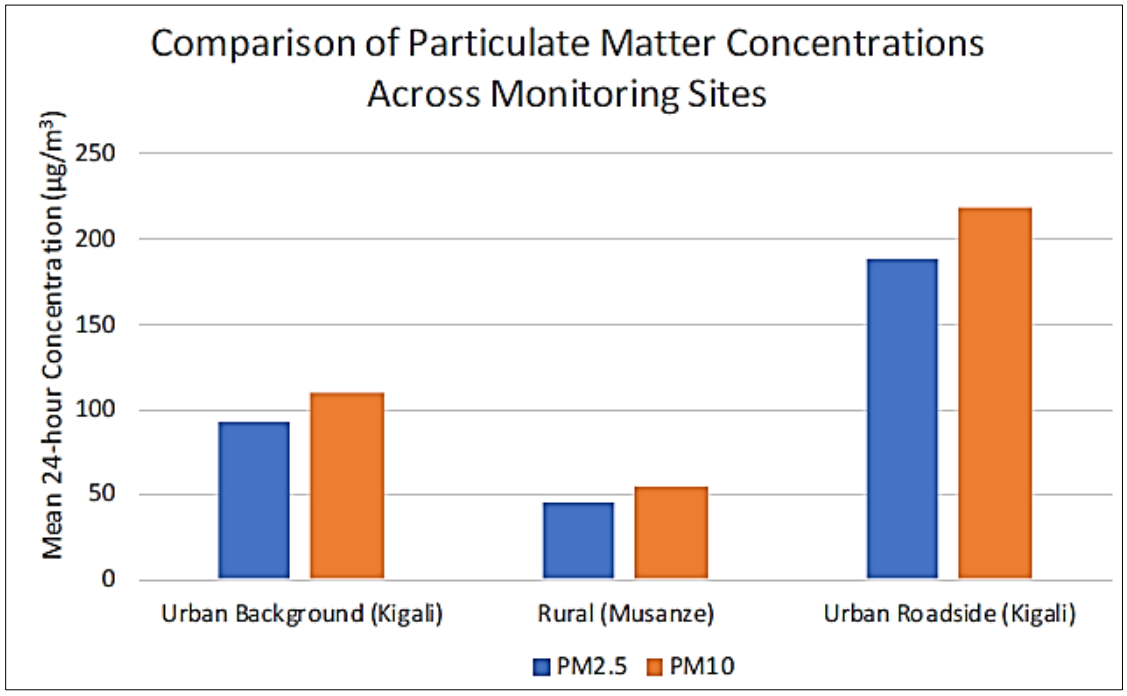
2.2.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

Kigali's baseline[26] air quality data published in January 2018 indicates significantly elevated urban background concentrations of PM_{10} and $PM_{2.5}$ in the city that is well above international standards. This data is consistent with an earlier 3 month study conducted in 2017 that also found that PM2.5 and PM10 levels in Kigali exceeded WHO guidelines and that during public holidays and Kigali car-free days, air pollution reduced compared to normal working days as there are fewer cars on the road[27] . The studies point to emissions from domestic stoves (wood fuel) as the main influencers of background PM concentrations. In addition, the studies point to significantly high PM_{10} and $PM_{2.5}$ concentrations near busy roads in Kigali city, an indication that road traffic is the most significant contributor to high PM concentrations near busy roads[28].

Figure 5 below shows the mean measured 24-hour PM2.5 and PM10 concentrations at urban roadside and urban background locations in Kigali as well as a rural site in Musanze District.

[26] *REMA, 2018*
[27] *Kalisa, E., et al., Temperature and Air Pollution Relationship in Kigali, Rwanda, 2017, IN University of Rwanda (UR) Scientific Conference Week publication: 'Rebranding Research for Sustainable development. Kigali: University of Rwanda, pp.*
[28] *Ibid*

Figure 5: Mean measured 24-hour $PM_{2.5}$ and PM_{10} concentrations at different sites



Source: REMA, 2018

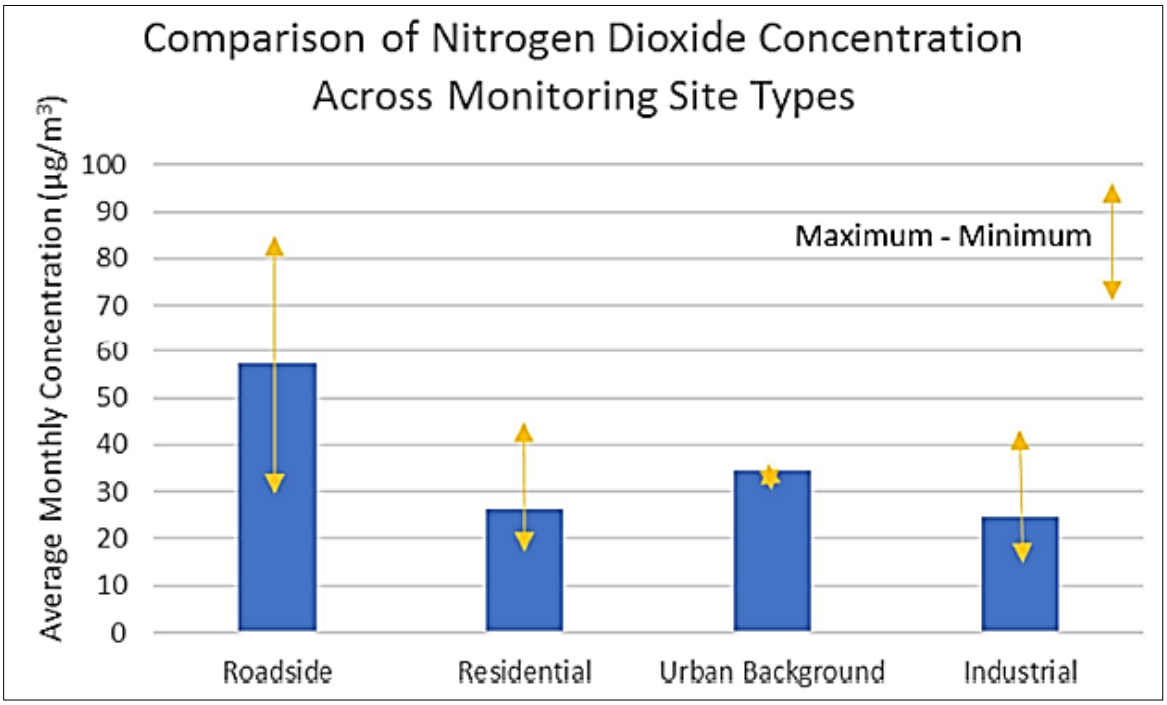
2.2.2 Nitrogen dioxide

The main contributor of NO_2 into Kigali City's air pollution is motor traffic. Baseline air quality data for Kigali shows that NO_2 concentrations are high and above international standards mainly along busy roads within the city. The data indicates that unlike in Kigali City, NO_2 concentrations are not as significantly elevated across the whole country[29].

Figure 6 below shows the average monthly NO_2 concentrations from passive air quality monitoring at different sites in Kigali city.

[29] *Ibid*

Figure 6: Summary of passive air quality monitoring results for NO_2



Source: REMA, 2018

2.3 Other important air pollutants

Although other air pollutants such as Sulphur dioxide (SO_2), Carbon Monoxide (CO) and Ozone (O_3) are important to note, they are not of major concern in Kigali City at the moment because their measured baseline levels show concentrations that are well within the limits of international standards and best practice.

2.3.1 Sulphur dioxide (SO_2)

The contributors of SO_2 in Kigali city are traffic as well as power plants and industrial processes such as cement production. SO_2 levels in Kigali are currently well below the WHO limits as well as the Rwanda standards. Measured SO_2 baseline concentrations across different monitoring sites in Kigali show generally low concentrations and indicate no significant difference between roadside, urban background, residential industrial locations[30].

[30] *Ibid*

Table 3 below shows a summary of passive air quality monitoring results for SO_2 across different monitoring sites in Kigali.

Table 3: Summary of passive air quality monitoring results for SO_2

Site type	Average (µg/m3)	Minimum (µg/m3)	Maximum (µg/m3
Roadside	<4.7	<4.0	<5.3
Residential	<4.8	<4.2	<5.4
Urban background	<4.7	<4.0	<5.4
Industrial	<4.8	<4.2	<5.4

Source: REMA, 2018

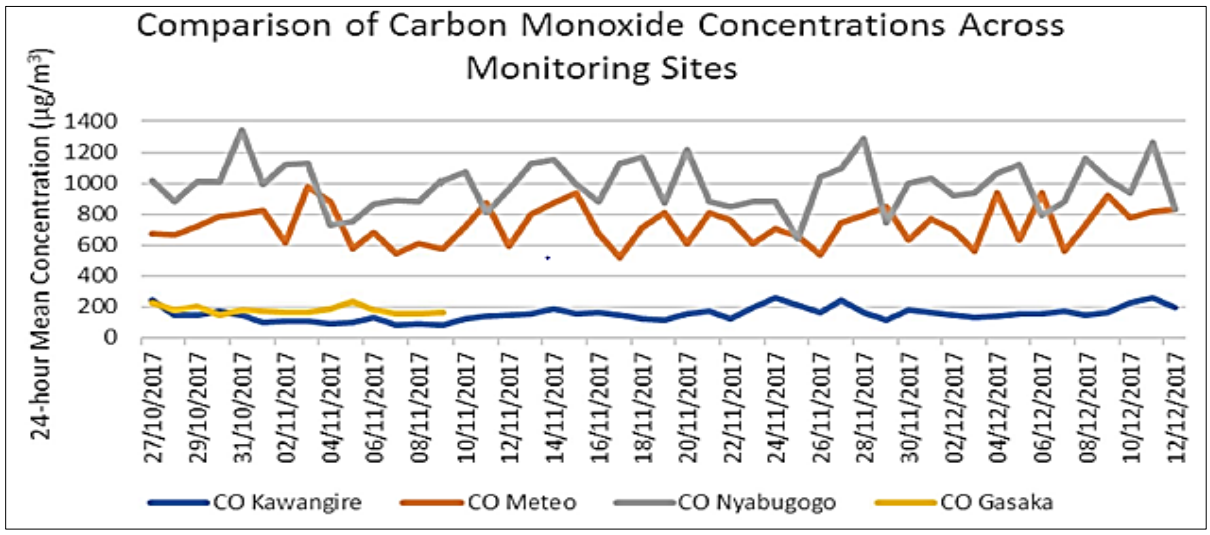
2.3.2 Carbon monoxide (CO)

Motor traffic and domestic cooking and heating (wood fuel) are the main sources of CO emissions in Kigali city with peak concentrations occurring at street level in busy and congested roads as well as high population density areas compared to rural areas of Kigali. As of 2018, the levels of CO in the air of Kigali city are still below the WHO limits[31].

Figure 7 below shows a comparison of measured CO levels across different monitoring sites between October and November 2017.

[31] *Ibid*

Figure 7: Comparison of CO levels across different monitoring



Source: REMA, 2018

2.3.3 Ozone (O_3)

The main contributors of ground level O_3 in Kigali are motor vehicles and industrial processes. Baseline data shows that high ground O_3 concentrations in Kigali are experienced during the dry season, at busy roadsides, and in the morning[32]. The ozone concentrations in the city are however still generally lower than WHO limits[33].

Table 4 below shows the average measured concentrations O3 at different monitoring sites in Kigali

Table 4: Average O_3 concentrations at different monitoring sites

Site type	Mean concentration (µg/m3)
Nyabugogo (Roadside)	58.9
Gitega – Meteo (urban background)	42.4
Kawangire (rural)	33.0
Gasaka	149.0

Source: REMA, 2018

[32] *Ibid*
[33] *Ibid*

2.4 Major sources of ambient air pollution in Kigali City

The major sources of ambient air pollution in Kigali include:

i. Emissions from road traffic
ii. Emissions from power generation and
iii. Emissions from industrial sources

2.4.1 Road traffic emissions

The transport sector remains a major source of urban air pollution in Kigali city. According to the UN Environment, motor vehicles account for up to 80% of urban air pollution in most developing country cities[34]. The main pollutants of concern from motor vehicles in Kigali are NO_2 and $PM_{2.5}$. Additionally, cars also emit CO and Unburnt hydrocarbons (HC) even though these are currently not of major concern in Kigali.

As of 2017 Rwanda had a total of 191,015 registered motor vehicles (including motorcycles and three wheelers/auto rick Shaws)[35]. Of this number, new vehicles account for only 15 per cent with imported used vehicles accounting for 85 per cent[36]. In addition, 95.2 per cent of Rwanda's total vehicle fleet are older than 10 years (registered before 2005).[37]

Table 5 below shows the trend of vehicle population growth in Rwanda.

Table 5: Trend of growth of vehicle fleet in Rwanda

Vehicle Type	Number of registered vehicles by year						
	2011	2012	2013	2014	2015	2016	2017
Car	19,109	22,699	24,834	26,850	30,238	33,080	34,378
Pick Up	13,213	14,472	15,163	15,734	16,402	17,245	17,703
Jeep	13,349	15,828	17,361	18,583	20,276	22,292	23,673
Minibus	5,043	5,528	5,827	6,058	6,160	6,283	6,325
Microbus	138	147	151	153	254	545	867
Trucks	3,089	3,378	3,738	4,070	4,961	6,049	7,781

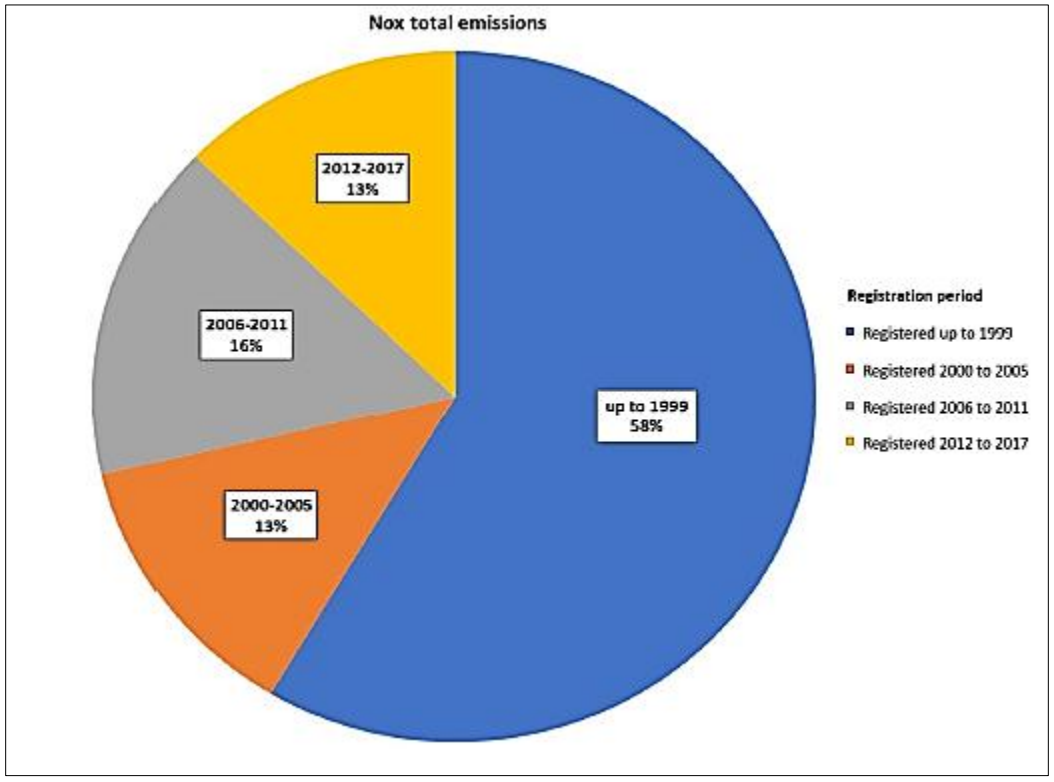
[34] *PCFV, Regulatory Toolkit for Clean Fuels and Vehicles, 2015*
[35] National Institute of Statistics of Rwanda, Statistical Year Book, 2017
[36] UNEP, Paper on review of global trade in used vehicles, 2017
[37] Ibid, ref 2

Bus	426	489	549	769	1059	1264	1408
Motorcycles	49,718	60,980	67,382	74,774	85,072	93,866	98,807
Tricycles/3-Weelers	18	61	63	68	73	73	73
Total	**104,103**	**123,582**	**135,068**	**147,059**	**164,495**	**180,697**	**191,015**

Source: National Institute of Statistics of Rwanda, Statistical Year Book, 2017

The baseline data from the 2018 REMA Inventory shows that the oldest registered vehicles (registered in 1999 or before) in the categories of articulated (artic) HGV's, Jeeps, minibus, pickups and rigid HGVs contributed more than 50% of the total emissions in Rwanda from these categories. For instance, the inventory shows that vehicles registered in or before 1999, which make only 28.6 per cent of the total vehicle population, contribute 58 per cent of total vehicle related NOx emissions in Rwanda[38] as shown in Figure 8 below.

Figure 8: Percentage of total vehicle NOx emissions by year of registration



Source: REMA, 2018

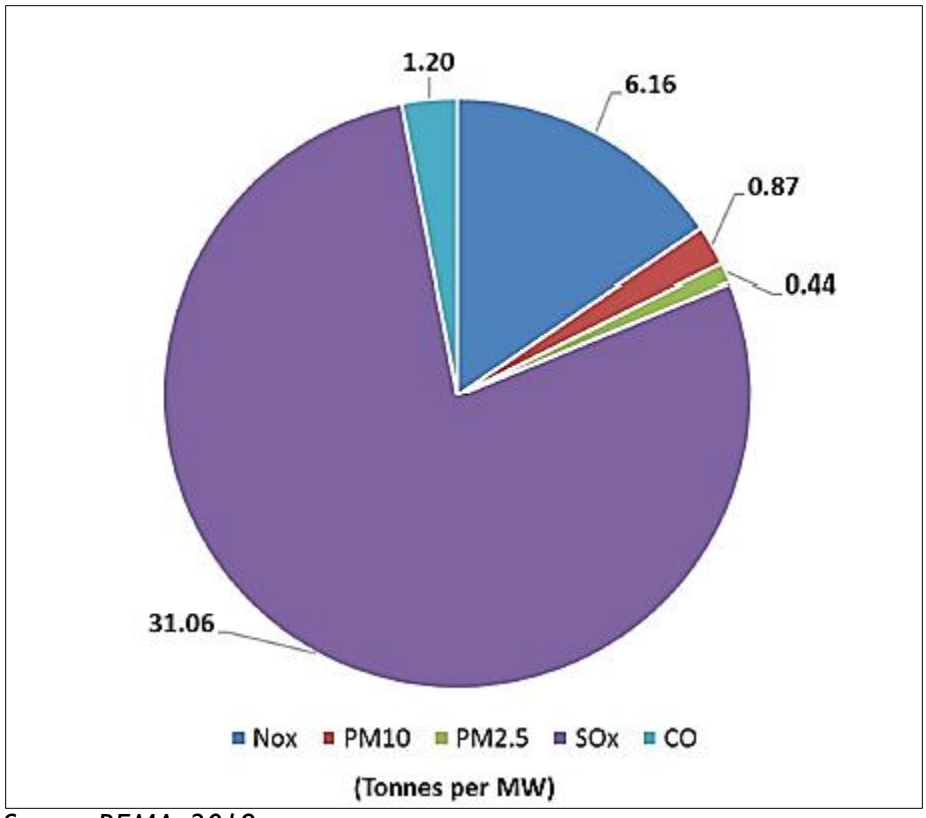
[38] *Ibid*

Noting that about 70 per cent of Rwanda's total vehicle population is in Kigali City[39], the contribution of road vehicles to the city's ambient air pollution cannot be ignored. As the number of vehicles in Kigali continues to grow, emissions from the transport sector will also increase putting the lives of more people at risk.

2.4.2 Emissions from power generation

Air pollutants associated with thermal power plants include NOx, PM_{10}, $PM_{2.5}$, SOx and CO. Whereas Rwanda has several power plants, none of these are located within Kigali close to residential receptors. In addition, most of the power plants have small installed capacity (ranging from 0.07 – 26.4 MW) hence their impact on air quality is localized with no significant impact on regional air quality or air quality within Kigali city.
Figure 9 below shows the estimated combined thermal power station emissions of NO_X, PM_{10}, $PM_{2.5}$, SO_X and CO per megawatt of installed capacity

Figure 9: Combined thermal power station emissions per MW



Source: REMA, 2018

[39] *Nduwayezu, et al., Quantification of Air Pollution in Kigali City and Its Environmental and Socio-Economic Impact in Rwanda, American Journal of Environmental Engineering, 2015*

2.4.3 Emissions from industrial sources

Rwanda's industrial sector is relatively small contributing about 16 per cent[40] of the county's GDP but is expected to grow to 26% by 2020[41]. It is estimated that about 63% of all industries in Rwanda are located in and around Kigali,[42] which implies concentration of industrial pollution in the capital. Most of the industrial activities are within the industrial park of Gikondo, in the zone of Kicukiro, as well as in periphery of the hill of Nyarugenge.

Most of ambient air pollution from Kigali's industrial sector comes from construction and manufacturing facilities. PM10 and PM2.5 are the main emissions from the construction industry from activities such as demolition and earthworks as well as NO_2 and PM_{10} that are associated with energy use. The key sources for these emissions in Kigali are cement factories, construction sites and small-scale brick kilns. The construction sector accounted for 51% of the total contribution of the industrial sector's contribution to the GDP followed by manufacturing at 40% and mining and quarrying at 8% with water and electricity contributing only 1% in 2011[43]. About 75% of firms in Rwanda have access to private generators 45% of which purely depend on these generators for electricity production[44] .

For the manufacturing sub-sector, it is estimated that 45% of their energy comes from furnace/heavy oils and another 3% from wood, both of which produces significant amount of emissions[45]. The manufacturing industry in Kigali and Rwanda as a whole is still small hence emissions from this sub-sector are relatively small and localised.

2.5 State of air quality monitoring in Kigali City

2.5.1 Overview

Just like most of Sub-Saharan Africa cities, Kigali has in previous years lacked reliable air quality data due to limited monitoring. However, since 2017, air quality monitoring in Kigali city and the rest of Rwanda is currently on-going under the Rwanda Air Quality and Climate Change Monitoring Project. Thus, going forward it is expected that continuous air quality data will be

[40] National Institute of Statistics of Rwanda, GDP National Accounts, 2017
[41] Rwanda Vision 2020
[42] Rwanda Association of Manufacturers. Overview of Rwandan Manufacturing Industry, 2015
[43] Ministry of Trade. Rwanda Industrial Survey, 2011.
[44] GeoHealth Hub for Eastern Africa, University of Rwanda. Situational Analysis and Needs Assessment for Rwanda Report, 2016

[45] Ibid

available. This project is led by REMA and involves collection and processing of air quality data to inform decision-making and enforcement activities for air pollution control and build climate change and air quality research expertise[46].

2.5.2 Active Air quality Monitoring

Active/ continuous air quality monitoring in Kigali started late 2017 and is done in two locations namely at Nyabugogo bus terminus (road side site) and at the Meteo Rwanda headquarters (urban background site).

Real time continuous air quality monitoring at these two sites are done using AQMesh monitors for the following pollutants;

i. Oxides of nitrogen (NOx)
ii. Nitrogen dioxide (NO2)
iii. Sulphur dioxide (SO2)
iv. Ozone (O3)
v. Carbon monoxide (CO)
vi. Particulate matter (PM10 and PM2.5)

2.5.3 Passive air quality monitoring

Passive ambient air quality monitoring is currently being undertaken in 30 sites in Kigali city and is carried using diffusion tubes. However, some of these sites are prone to vandalism[47].

2.5.4 Ambient air quality monitoring instrument

The table 6 below provides a snap shot of instruments used for monitoring air quality in Kigali city.

[46] *Fonerwa, Rwanda Air Quality and Climate Change Monitoring Project, 2017*
[47] *Ibid*

Table 6: Ambient air quality monitoring instruments in Kigali

Type of instrument	Pollutant monitored	Location
AQMESH AQ monitors	PM2.5, Ozone, NOx, SO_2, CO	Meteo Rwanda headquarters and Nyabugogo bus terminal
RAMPS (Real-time affordable multi-pollutants)	PM2.5, Ozone, NOx, SO_2, CO	Kyaciru
Air quality reference station	PM2.5, Ozone, NOx, SO_2, CO, VOCs, H_2S	Kigali
Aethalometer	▪ black carbon (particulates due to combustions, biomass burning and fossil fuel) ▪ Provide percentage of biomass burning versus soot	To be installed at Meteo headquarters
Aerosol chemical speciation monitor	▪ Measures composition of particulates, therefore, their source ▪ Can tell local versus remote sources of organic aerosol	Kigali Institute of Science and Technology (KIST)

Source: REMA. Inventory of Sources of Air Pollution in Rwanda Report 2018

2.6 Existing strategies to control air pollution in Kigali City

Current strategies to control air pollution in Kigali city include:

2.6.1 Promotion of public transport

The government has been promoting the use of public transport in Kigali city through development of a Public – Private partnership scheme that provides a comprehensive bus service to the urban population where only high capacity buses are allowed to provide public transport services. The government as well as private sector has provided subsidized and affordable public transport buses with an enhanced smart card ticketing system. This system has promoted public transport system in the city as well as reducing the number of trips associated with the low capacity buses[48].

[48] Kigali State of Environment and Outlook Report 2013

2.6.2 Vehicle maintenance and inspection programs

Currently all motor vehicles in Rwanda are required to undergo emissions inspection and testing at the Motor Vehicle Inspection Centre. Commercial vehicles must undergo emission inspection every six (6) months whereas passenger vehicles for personal transport must be inspected once a year. Any vehicle that does not meet applicable emissions standards is not authorized to operate in Rwanda[49]. In addition, all vehicles imported in Rwanda are required to be equipped with catalytic converters to reduce emissions[50]. As discussed in more detail in Chapter 3, the instructions are in force despite there being no national standards on vehicle emissions.

Existing testing infrastructure and capacity

The existing motor vehicle emissions inspection and testing infrastructure in Rwanda is as follows:

i) The main motor vehicle inspection and testing centre is located in Kigali City. This centre has 7 testing lanes - 4 lanes are used for light passenger and light commercial vehicles whereas the other 3 are used for heavy duty vehicles. Of the 7 lanes, 4 lanes have emission testing stations. The space at the centre is small hence parking for vehicles is a challenge.

ii) There is a mobile inspection and testing unit that rotates around the provinces away from Kigali City.

iii) A new motor vehicle inspection centre has been built at Rwamagana District in Eastern Province and is expected to be in operation before end of 2018. This centre has been designed as a training centre for motor vehicle inspectors but will also be used for inspection and testing of passenger cars and light duty commercial vehicles from neighbouring localities.

- *Despite motor cycles being key contributors to overall transport related air pollution in Rwanda, especially in Kigali City, the current emissions testing infrastructure in Rwanda have no facilities for testing and inspection of motor cycles. Should the new standard require emission testing for motor cycles, there will be need to expand the facilities to provide dedicated lanes and facilities in order to cope with the high numbers of motor cycles in Rwanda.*
- *For non-road mobile machinery including construction and farm equipment as well as hand held*

[49] Prime Ministers Instructions preventing air pollution caused *by* vehicular emissions**,** No. 004/Minifom/2010 of 14/09/2010 (Official Gazette No. 41 bis of 11/10/2010)

[50] *Article 6*

engine run equipment and generators, there are currently no tests for emissions provided for.

- *Currently, compliance with emission standards for factories such as power plants and cement factories is based on self-audits by the respective facilities. Capacity of REMA and other regulatory agencies needs to be enhanced to be able to monitor and test compliance based on control audits.*

Testing Equipment and parameters tested

MAHA Maschinenbau Haldenwang GmbH & Co. KG[51] – a German company which manufactures motor vehicle inspection and workshop equipment – is currently the sole supplier of equipment (hardware and software) to Rwanda's motor vehicle inspection centres. According to the Kigali inspection centre's management (Rwanda National Police), the current set of equipment was sourced through Rwanda Development Board (RDB), and there is a standing service agreement between RDB and MAHA that ensures the latter provides annual service and maintenance to the equipment, as well as emergency back-up. MAHA's official website also indicates that the company provides to its clients optimum customer care throughout the entire life cycle of the product – this includes installation, servicing, repair and calibration of equipment.

The current equipment at the centre is ***MET 6.3 Exhaust Gas Combitester*** series. This is a combination of MET 6.1 (gasoline/gas) and MET 6.2 (opacimeter) in a compact housing.

[51] *See MAHA's official website at http://www.maha.de*

- *The MET 6.3 Exhaust Gas Combitester has the capability to measure HC, CO, CO_2, O_2, NO_X (option), K value, turbidity, and PM mass concentration. This equipment is available with two point calibration (MET6.3/2). Currently, however, Rwanda's equipment is calibrated to measure all the above parameters except NO_X, turbidity, and PM mass concentration[52]. The current target values are based on the manufacturer's default settings as follows:*
  - ✓ *Measurement for diesel engine – target value k- max. 5.00 m^{-1}*
  - ✓ *Measurement for gasoline engine – target values: CO 5% vol. maximum; HC 600 ppm maximum; CO_2 10% vol. minimum, O_2 6% vol. maximum.*
- *Pass or fail for all emissions inspections are currently based on the above manufacturer settings as there is no enforceable national standard in place.*
- *It possible to recalibrate the equipment to measure the additional/missing parameters (i.e. NO_X, turbidity, and PM mass concentration) if need be, and also to set new target values (lower or higher) as may be required by new national standards currently being developed.*

2.6.3 Installation and Automation of traffic management system

The government has in the recent times installed and automated many traffic lights junctions in Kigali aimed at ensuring a smooth traffic flow and reducing traffic thus reducing emissions from motor vehicles when on traffic.

2.6.4 Adoption of low sulphur fuels

Rwanda adopted the harmonized East Africa Standards on clean fuels as their national standards, a move that led to introduction of clean and low sulphur fuels. The current fuels used in Kigali are of 50ppm sulphur content for diesel and 150ppm for petrol effective January 2015. The use of clean fuels helps in reducing tail pipe emissions from vehicles thus reducing emissions from vehicles[53].

2.6.5 Investment in and promotion of clean energy

A lot of investment by the government of Rwanda in electricity generation from renewable energy sources are on-going in both hydropower, Geothermal and wind power resources in a

[52] *We obtained print-outs of actual test results at the Kigali inspection centre and were able to view the actual parameters tested.*
[53] *EAS 158: 2012 and EAS 177: 2012*

bid to increase the installed capacity. However, the EDPRS II target for an installed capacity of 563 MW by 2018 was has not been met, but current capacity is sufficient to meet all household and industrial demand[54].

A Government programme to support the use of improved cooking technologies has been running since the 1980s with 30% household penetration. Private sector led efforts are also distributing cook stoves that are up to three times more efficient than the traditional 3-stone stove and can reduce biomass consumption by anywhere between 68-94%[55] .In addition, different solar PV systems have been installed in various institutions such as public offices, health centres and schools in a bit to promote the use of solar energy.

2.6.6 Car free days and Car free zones

Car free days are usually held every month in Kigali City by the City of Kigali, every first Sunday of the month. The residents are not allowed to drive their cars within certain roots in the city between 7am and 12 pm since such roots are used by city residents to engage in sports, meet their neighbours as they learn more on environmental protection and the impacts of driving their cars on air quality.[56]

Car free zones have also been introduced in Kigali by City of Kigali including KN 4 Ave, KN 78 St and KN 84 St. Vehicles are neither allowed to pass nor park at the designated zones.

2.6.7 ***Development of Non-Motorized Transport (NMT) facilities***

The government through the City of Kigali has developed and maintained pedestrian walks in the CBD area as well as roads in the Gasabo District aimed at promoting the use on NMT facilities in the city and is in the process of developing more walking and cycling facilities[57]. The government has also made it a requirement for all new roads to have NMT facilities.

[54] *MININFRA, Energy Sector Strategic Plan 2018/19-2023/24*
[55] *Ibid*
[56] *City of Kigali official website, accessed May 2018*
[57] *City of Kigali. Kigali City Analysis, Bench Marking and Vision Report 2013,*

2.7 Challenges and emerging threats to future air quality monitoring in Kigali city

2.7.1 Rising vehicle fleet

The main challenge to air quality faced by many countries is stemming the rising vehicle emissions owing to the ever increasing vehicle fleet in these countries. Transport sector remains the main contributor to air pollution in many cities[58]. The vehicle fleet in Kigali is however still very small compared to other cities but the increasing vehicle fleet in the city especially motorcycles remains a challenge to achieving good air quality in the city.

2.7.2 Energy mix

Although the government of Rwanda is focusing on the use of modern, clean and energy efficient technologies for the production of energy, energy production is largely from biomass, occupying 85% of the total energy mix. The hydropower and other indigenous sources accounting for more than 60% and less than 40% of the energy is from diesel-powered generators[59]. On-going investments in thermal (heavy fuel oil) energy by the government will continue to be a challenge to improving local air quality especially in areas where such power plants are installed. Besides, the use of biomass energy for cooking and heating still remains a threat to achieving good air quality hence the need to intensify promotion of cleaner cooking fuels and technology such as LPGs and clean cook stoves in the city.

2.7.3 Increasing infrastructural /Construction projects

Major infrastructural / construction projects carried out in Kigali city have contributed to ambient air pollution especially from particulate matter and those emissions associated with energy use during construction and demolition of such projects over the last decade. Emissions from this sector will continue to be a challenge to air quality since it heavily dependent on furnaces/heavy oils, as Rwanda grows towards becoming a middle income country by 2020

2.7.4 Climate change

Climate change risks to public health and the environment are substantial and far-reaching. It can lead to more frequent flooding, increased drought, and more severe wildfires among others

[58] *Ibid*

[59] *Uwisengeyimana, et al., Current Overview of Renewable Energy Resources in Rwanda. Journal of Energy and Natural Resources. 2018*

- events that can cause deaths, injuries, and billions of dollars of damage to property and the nation's infrastructure. Climate changes can also impact on ambient air quality by for instance, ground-level ozone thus may be a challenge for compliance with the ozone standards in the future[60].

2.7.5 Trans - boundary air pollution

Emissions in Kigali is not only from the sources within the city but also from Tran's boundary sources such as emission from trans boundary forest fires from neighbouring countries such as Uganda and DRC Congo. Tackling this will require a regional approach hence will continue to be a challenge to ambient air quality in Kigali city if such strategies are not developed.

2.7.6 Limited technical capacity

Rwanda is currently making process towards installation of a national air quality monitoring network, but this is likely to be a challenge since the country lacks adequate skilled personal for maintenance and repair should equipment used in air quality monitoring and analysis fail. Technological transfer is will be key from the equipment manufacturers to ensure success of such project[61].

2.7.7 Limited resources

Air quality monitoring in Kigali could further be hampered by the limited resources to compute, analyse and share air quality data as well as maintenance and repair of air quality monitoring infrastructure.

[60] *USEPA official website, accessed June 2018*

[61] *Ibid, ref 25*

SECTION III

3.0 CURRENT POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK FOR AIR POLLUTION CONTROL IN KIGALI CITY

This section provides a detailed analysis of the current policy, legislative regulatory landscape for air pollution control in Kigali, Rwanda.

3.1 POLICIES

3.1.1 Rwanda Vision 2020[62] and Second Economic Development and Poverty Reduction Strategy (EDPRS 2)[63]

The Vision 2020 is a reflection of the aspiration and determination of the people of Rwanda to construct a united, democratic and inclusive Rwandan society. The Vision aims to transform Rwanda, by the year 2020, into middle - income nation in which all Rwandans are healthier, educated and generally more prosperous. The vision also seeks a country that is competitive both regionally and globally.

Environmental protection and sustainable management of natural resources are important elements in the pillars of Vision 2020. Specifically, it is envisioned that by the year 2020, Rwanda will be a nation in which the pressure on natural resources, particularly on land, water, biomass and biodiversity, has significantly been reduced and the environmental pollution and degradation has been reversed; a nation in which the management and protection of these resources and environment are more rational and well regulated in order to preserve and bequeath to future generations the basic wealth necessary for sustainable development.

The Vision is being implemented progressively through medium term plans and strategies, the current one being the Second Economic Development and Poverty Reduction Strategy (EDPRS 2). This is a five-year plan (2013 – 2018) designed to accelerate the progress already achieved and to shape Rwanda's future development. It builds on policies from EDPRS 1 which were effective in accelerating growth, creating employment and generating exports. The overarching goal of EDPRS 2 is "accelerating progress to middle income status and better quality of life for all Rwandans through sustained average GDP growth of 11.5% and accelerated reduction of poverty to less than 30% of the population".

[62] *Republic of Rwanda, Ministry of Finance & Economic Planning, 2000*
[63] *Republic of Rwanda, Ministry of Finance & Economic Planning, 2013*

As the year 2020 approaches, plans are already underway to transition from Vision 2020 to Vision 2050. In this updated Vision, Rwanda will work towards reaching upper middle income status by 2035 and high income status by 2050. This will require average annual growth of above 10 per cent (almost doubling the current economic growth rate)[64]. Economic transformation through off-farm investment and employment creation will be key towards achieving this goal. This is likely to come with rapid industrialization and urbanization, with the potential to generate different forms of urban pollution including air pollution. As such, strengthening of public institutions responsible for environmental protection and natural resources management will continue to be central to the achievement of the aspirations of Vision 2020 as well as Vision 2050.

3.1.2 Rwanda Environmental Policy[65]

The overall objective of the Rwanda's Environmental Policy is the improvement of human well-being, the judicious utilization of natural resources and the protection and rational management of ecosystems for sustainable and fair development. In furtherance of this objective, the policy seeks to set out institutional and legal frameworks for coherent and harmonious coordination of sectorial and cross-cutting environmental policies.[66] The policy recognizes air pollution as an emerging problem, though at the time writing the policy in 2003 air pollution was blamed mainly on emissions from the few industries in the country, especially in Kigali City.

The industrial sub-sectors of major concern under the Rwanda Environmental Policy include: agro industry, textiles, wood, chemical industries, construction, mining, metallurgical industries, engineering, printing and paper industries. Most of these industries are located in the city of Kigali and are singled out due to their potential negative effects on human health and environment. The Policy also recognizes transportation as a key source of air pollution.

Other than industrial and transportation related sources of air pollution, Rwanda's Environmental Policy does not expressly address other potential anthropogenic sources of air pollution such as waste; agriculture, domestic cooking, construction, mining and quarrying. As such there are no clear strategic actions in the Policy to deal with potential air pollution from these sources. Despite this noted shortcoming, the Policy is still forward looking and has made provision for various strategic actions[67] necessary to prevent air pollution from various sources that are relevant for Kigali City. These strategic actions include:

- ✓ *Ensuring that development projects include prior environmental impact assessments;*

[64] *Republic of Rwanda, Ministry of Economic Planning, 2016*
[65] *Republic of Rwanda, Rwanda Ministry of Lands, Resettlement & Environment, 2003*
[66] *Ibid, Ch. 4*
[67] *Ibid, Ch.5*

- ✓ *Developing master plans and special plans for land-use in urban areas;*
- ✓ *Developing and implementing regulations to minimize pollution from land, lake and air transport;*
- ✓ *Preventing air and soil pollution by emissions of gases and heavy metals from transport equipment;*
- ✓ *Promoting the use of non-polluting sources of energy;*
- ✓ *Regulating the location and management of industrial sites;*
- ✓ *Putting in place mechanisms for the prevention and control of bush fires;*
- ✓ *Ensuring compliance with international standards in the emission of greenhouse gases due to utilization of energy;*
- ✓ *Developing a policy for the control of socio-economic activities likely to affect the climate;*
- ✓ *Establishing legislation aimed at monitoring regularly climatic changes and reducing to the strict minimum substances which pollute the atmosphere.*

3.1.3 Rwanda Public Transport Policy[68]

The vision of the Government of Rwanda on the issue of transport as outlined in Vision 2020 is a transport system with modern infrastructure and cost effective and quality services that gives due regard to safety and environmental concerns. The Public Transport Policy and Strategy came into operation in 2012 and outlines the current status, strategies, priorities and action plan for inter-city, rural, international and urban public transport system for Rwanda.

The Policy recognizes that the current rapid growth in the population of Kigali City has also been coupled with a similar increase in private car ownership, a situation likely to induce more congestion and pollution. Some of the general public transport problems in Kigali City that are highlighted by the Policy include:

- Lack of proper transport planning and design;
- Lack of dedicated bus lanes to give priority to public transport;
- Increase in air pollution levels.

The following are some of the priority actions for the public transport sector that are envisaged under the Policy:

i) Establishing an urban public transportation system in Kigali City to reduce congestion, pollution and costs;

[68] *Republic of Rwanda, Ministry of Infrastructure, 2012*

ii) Developing strategies to manage heavy duty vehicles within Kigali Central Business District;

iii) Developing non-motorized transport (NMT) infrastructure – pedestrian sidewalks and cycle lanes – in Kigali and other cities.

- *The Public Transport Policy currently only addresses road-based public transport services. However, development of a new comprehensive national transport policy for Rwanda is planned by the Ministry of Infrastructure (MININFRA) and will cover public transport, freight, road development, parking development and management, NMT, road traffic management, axle load control and inland water transport[69].*
- *Other existing initiatives in the transport sector that are likely to have a positive impact on the air quality in Kigali City include:*
  - ✓ *REMA is commissioning a feasibility study on the phase-out of fossil fuel (gasoline and diesel) powered motor-vehicles and the phase-in of electric motor vehicles in Rwanda. This will go hand in hand with a pilot project for introduction of electric motor cycles.*
  - ✓ *There are on-going discussions on proposals to bring motor cycles into emissions inspection and testing requirement, and to procure additional mobile emission testing equipment in order to cover the entire country effectively.*
  - ✓ *MININFRA is spearheading the development of a Master Plan for Motor Vehicle Inspection (with support from Japan) with a view to restructuring the current institutional set-up to make it more efficient, especially in view of the rising vehicle fleets and the proposal to also start inspection and testing for motor cycles which are very large in numbers.*
  - ✓ *There are plans to build a new expressway to act as a city bypass in order better disperse traffic from Kigali CBD, especially heavy duty vehicles (HDVs).*
  - ✓ *The City of Kigali is already implementing car free zones and car free days within the city.*

3.1.4 Rwanda National Energy Policy[70]

The vision of the energy sector as outlined in Rwanda's National Energy Policy is to contribute effectively to national economic growth and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner. The policy outlines environmental goals for various energy sub-sectors and demand categories.

[69] *Interview with MININFRA, 23 May 2018*
[70] *Republic of Rwanda, Ministry of Infrastructure, 2008*

Biomass Sub-sector

The Policy recognizes biomass fuels, particularly wood fuel and charcoal as the most accessible and affordable sources of energy for most of the Rwandan population. To promote development of this sub-sector the Policy supports, inter alia, the following actions:

- Improved technologies for charcoal production and improved stoves.
- Promotion of other energy sources for cooking and heating such as biomass briquettes (peat, papyrus, waste), kerosene, LPG, solar water heating and electricity (for users in the high end market).
- Dissemination of biogas digesters to rural families.
- Production of methane or other forms of energy from solid waste landfills or through gasification processes is also to be encouraged.

Air pollution in Rwanda (both ambient and indoor) has been attributed to various sources with biomass, especially wood fuel, charcoal and kerosene in domestic cooking and lighting as one of the major sources. As such, full implementation the above policy actions for efficient and/or alternative energy sources will reduce emissions from the biomass sub-sector.

Petroleum Sub-sector

Rwanda currently imports all its petroleum products and this represents a significant cost to the country's foreign currency resources. The policy goals for the petroleum sub-sector are both upstream (exploration and potential production) and downstream (importation of refined products). The upstream policies are geared towards ensuring that oil exploration is carried out. In addition, should oil or gas resources be identified, the necessary upstream developments necessary to exploit these resources with optimal degree of processing of crude will be pursued.

Energy demand categories

The national Energy Policy goes further to make policy statements for various energy demand categories. The relevant policy statements for various energy demand categories with potential implications on air quality not only in Kigali City but also for the entire country are the following:

- ***Agriculture*** – the policy encourages energy efficiency in ploughing and transportation, where these activities are mechanised, and in irrigation, coffee washing stations, agro-processing and other agricultural activities.
- ***Transport*** – the policy aims at, among others, reducing pollution by encouraging the use of environmentally friendly fossil fuels such as unleaded petrol and low sulphur diesel; promoting energy efficiency through proper maintenance of vehicles and good driving

practices and encouraging the development of mass transport systems in order to reduce the proliferation of individual goods and passenger vehicles.

- ***Industry and services*** – the policy seeks to: create awareness of the importance of using cleaner energy sources and including environmental performance in energy audits and energy management strategies; encouraging efficient use of alternative environmental friendly energy sources; and improving coordination of institutions concerned with energy, industry and environmental issues.
- ***Household energy*** – the policy aims at, among others, ensuring reliable supplies of energy at the household level, particularly to low income households; offering training and improved stoves to increase the efficiency in the use of biomass resources; promoting alternative forms of energy for household use to reduce the time burden and the health risks especially for women; and ensuring that new technologies meet the highest health and safety standards.

3.1.5 Rwanda National Industrial Policy[71]

Rwanda's National Industrial Policy recognizes the importance of diversification of the Rwandan economy into new sectors of activity as an essential element towards meeting the goals set out in the country's Vision 2020. Although the industrial sector is currently small, contributing on average around 15 per cent of GDP as of 2011, the Policy projects that for Rwanda to reach the Vision 2020 target, it requires the share of industry to increase to at least 26 per cent of GDP. This will oblige the industrial sector to outstrip services and agriculture sectors by recording at least 12% growth annually[72].

The National Industrial Policy recognizes that economic activities may in some cases have negative impacts, for example where the waste produced by industrial processes is harmful to the environment and to the businesses and people who rely on it. The policy therefore encourages mitigating measures to be taken so that economic growth can take place in a sustainable long-term manner.

It is estimated that about 70 per cent of industries in Rwanda are located in Kigali, which implies concentration of industrial pollution in the capital[73]. Most of the industrial activities are within the industrial park of Gikondo, in the zone of Kicukiro, as well as in periphery of the hill of Nyarugenge.

[71] *Republic of Rwanda, Ministry of Trade and Industry, 2011*
[72] *Ibid*
[73] *Ibid*

In recent years, there have been increased industrial investments in Kigali following the establishment of the Kigali Special Economic Zone (KSEZ) that provides access to better road infrastructure and other utilities such as reliable access to electricity, water and sanitation, and a fast internet connection. The KSEZ also offers better trade facilitation (expedited customs procedures and a greater likelihood of entering into the Duty Remission Scheme that offers import duty exemptions). This increased industrial activity is likely to be accompanied by increased pollution of appropriate mitigation measures are not put in place. Among the actions that the National Industrial Policy promises to deliver include:

- *Enforcement the implementation of Rwanda's environmental laws and policies in order to prevent/control different forms of industrial pollution.*
- *Sensitization of industrialists and enforcement of cleaner production systems in all industries*
- *Encourage industries to locate in industrial parks and special economic zones to benefit from centralized industrial waste management systems;*
- *Enforce the establishment of industry specific waste management system.*

3.2 LAWS

3.2.1 Constitution of Rwanda[74]

The Constitution of the Republic of Rwanda guarantees every person the right to a clean and healthy environment[75]. In addition, the Constitution places an obligation upon everyone in Rwanda to protect, safeguard and promote the environment. The State has a duty to ensure the environment is protected by undertaking various measures including the establishment of laws that outline the modalities for protecting, conserving and promoting the environment[76].

The Constitution also guarantees all Rwandans the right to good health[77]. In this regard, State has the duty to mobilize the population for activities aimed at good health and to assist them in the realization of those activities. In addition, every Rwandan has the duty to take part in activities aimed at good health[78].

The Rwandan Constitution lays down a very strong foundation for environmental safeguards not only towards realization of the right to a clean and healthy environment but also for good health. Air quality management and pollution control are important environmental safeguards in this respect.

[74] *Republic of Rwanda (2003 with amendments through 2015), Special Official Gazette of 24/12/2015*
[75] *Ibid, Article 22*
[76] *Ibid, Article 53*
[77] *Ibid, Article 21*
[78] *Ibid, Article 45*

3.2.2 Organic Law Determining the Modalities of Protection, Conservation and Promotion of Environment in Rwanda[79]

This organic law is intended to determine the modalities of protecting, conserving and promoting the environment in Rwanda as envisaged by the country's Constitution. Among the specific aims of the organic law include the need to guarantee to all Rwandans sustainable development which does not harm the environment and the social welfare of the population; and the need to put in place strategies for environmental protection and mitigation of negative effects of any activities on the environment.[80]

Just like in the Constitution, the organic law not only guarantees everyone in Rwanda the right to a clean and healthy environment but also imposes a responsibility on the state to protect, conserve and promote the environment. In addition, the law places a duty on every person in Rwanda to protect, conserve and promote environment[81].

The organic law has several provisions aimed at protecting and preserving air quality. The law requires that all buildings, vehicles and engine driven machines, commercial, craft or agricultural activities, be operated and used in accordance with technical principles that may be established by competent authorities in order to preserve the integrity of the atmosphere[82]. Prohibited activities under the organic law include: open burning of domestic waste, rubbish, wheels, tyres and plastic materials; owning and/or operating a car that emits smoke and noxious gases; and smoking in public places[83]. The organic law also requires that all projects, programmes and policies likely to have an impact on the environment be subjected to environmental impact assessment (EIA) before obtaining authorization for implementation. The list of projects subject to EIA is determined by an Order of the Minister responsible environmental affairs[84].

The organic law prohibits burning mountains, swamps, grazing land, bushes for agricultural or grazing purposes. However, burning of forests, bushes, National Parks as well as reserved areas may be permitted by the Minister in charge of environmental affairs in situations aimed solving particular problems[85].

The law empowers the Minster in charge of environmental affairs to issue orders and regulations regarding any activities that may pollute the atmosphere, including the use of any

[79] *Republic of Rwanda, Organic Law No. 04/2005, Official Gazette of 08/04/2005*
[80] *Ibid, Article 1*
[81] *Ibid, Article 3*
[82] *Ibid, Article 25*
[83] *Ibid, Articles 26, 109*
[84] *Ibid, Articles 67,68,69,70*
[85] *Ibid, Article38*

substances that may pollute the air, deplete the Ozone Layer or cause climatic changes[86]. In addition, all premises, agricultural, industrial, commercial or artisanal establishments, motor vehicles and other movable properties, are required to be constructed and used in a manner that conforms to technical standards that may from time to time be established for the implementation of the organic law.[87] Any activities that cause damage to the quality of air including the release into the atmosphere poisonous gases, smoke, waste, soot, dust and any other chemical substances are specifically prohibited.[88]

The Organic Law establishes the institutional framework for its implementation[89]. The institutions include:

i) Rwanda Environment Management Authority (REMA)- responsible for supervising and monitoring all environmental matters in Rwanda;
ii) National Fund for Environment in Rwanda (FONERWA) – responsible for mobilization and managing financial resources; and
iii) Committees responsible for environmental conservation and protection at the Provincial, City of Kigali, District, Town, Municipality, Sector and the Cell levels.

The Organic Law lays down the legal framework for putting in place mechanisms for air quality management for Rwanda generally but also for Kigali City. Of most relevance for Kigali are the provisions relating to the establishment of technical standards and limits for motor vehicle emissions as well as emissions from other types of engine operated machines and equipment. In addition, the establishment of the city level environmental conservation and protection committee for Kigali creates a great opportunity to manage and protect the city's air quality. The organic Law is currently under review with the aim of putting in place a new Law on Environment. A draft of the new law is currently under consideration by the Law reform Commission before presentation to Cabinet for approval and onward transmission to Parliament for enactment.

3.2.3 Law Determining the Mission, Organization and Functioning of Rwanda Environment Management Authority (REMA)[90]

This law outlines the functions, powers and administrative structures for the efficient functioning of the Rwanda Environment Management Authority (REMA). REMA is the national authority responsible for supervising and monitoring all environmental matters and ensuring that issues relating to environment are integrated in all national development programs in

[86] *Ibid, Articles 26 & 27*
[87] *Ibid, Article 80*
[88] *Ibid, Articles 81 & 88*
[89] *Ibid, Article 65*
[90] *Republic of Rwanda, Law No. 63/2013, Official gazette of 27/08/2013*

Rwanda. Among the many functions[91] of REMA outlined in this law, the following are key for air quality management in Kigali City:

i) to implement Government environmental policy;
ii) to advise the Government on policies, strategies and legislation related to the management of the environment as well as the implementation of environment related international conventions;
iii) to put in place measures to prevent climate change and cope with its impacts;
iv) to conduct studies, research, investigations and other relevant activities in the field of environment and publish the findings;
v) to monitor and assess development programs in order to ensure compliance with the environmental laws;
vi) to participate in designing strategies to prevent risks and other phenomena which may cause environmental degradation and propose remedial measures;
vii) to monitor and supervise environmental impact assessment, environmental audit, strategic environmental assessment and any other relevant environmental study.

As per the provisions of this Law, REMA has a critical advisory as well as implementation and enforcement role in measures aimed at protection of air quality in Rwanda generally and in Kigali City in particular. REMA has been granted several powers in order to fulfill its mission provided under this Law. Among these powers, the following are key for enforcement of relevant laws for the protection of air quality. REMA has power to:

- ✓ *request any institution or organ to submit an environment status report;*
- ✓ *visit without prior notice any project, building, industrial and business site in order to conduct inspection of activities harmful to environment;*
- ✓ *investigate offences in accordance with Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda; and,*
- ✓ *order the suspension of activities contrary to the provisions of Organic Law determining modalities of protection, conservation and promotion of the environment in Rwanda and other laws relating to the protection of environment;*

[91] *Ibid, Article 3*

3.2.4 Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda[92]

This Law determines modalities for preservation of air quality and prevention of air pollution in Rwanda. It applies to all measures aimed at the preservation of air quality and to all activities likely to affect air quality or pollute the atmosphere. This Law requires all persons engaged in different activities such as industries, transportation, construction works, storage, waste incineration, power plants, gas extraction, boilers, generators and furnaces to comply with the relevant air quality standards set by the Rwanda Standards Board[93]. An Order of the Minister may also determine other sites of specific activities that are considered as sources of air pollution[94].

- *Owners of any means of transport which is an emission source are required by the Law to control emission of air pollutants. Such means of transport must undergo an inspection for emissions control[95]. The Minister in charge of environmental affairs is obligated to issues an Order that determines the modalities and requirements for compliance with permissible emissions limits by the means of transport and other machines using petroleum products.*
- *Any person whose activity is likely to pollute the air beyond the set air quality standards is required to obtain a permit from REMA. An Order of the Minister determines requirements and modalities for applying, granting and using the permit.*
- *REMA is the main institution mandated by this Law to carry out inspection and monitoring of air quality compliance. REMA is required to work in close collaboration with all other relevant institutions for the purpose of enforcement of air quality standards[96]. However, when it comes to enforcement, specifically the issuance of protection or prevention orders and orders to stop activities that are polluting or are likely to result in air pollution or have adverse effect on public health, the Law gives equal and over-lapping powers over the same to REMA, City of Kigali and the District[97]. The lack of specificity and/or hierarchy in this regard may, in certain instances, create a gap in enforcement as each institution may wait for the others to act. It may also lead to institutional conflict over mandate should there be no agreed cooperation mechanism between the respective institutions.*
- *The Law also grants the City of Kigali and the Districts power to notify and require polluters to take measures to remedy emissions of air pollutants where the City of Kigali or the District notices any activity that causes emissions of air pollutants. Should such a polluter fail to find a*

[92] *Republic of Rwanda, Law No. 18/2016, Official Gazette of 18/05/2016*
[93] *Ibid, Articles 8,9,10,11,12,13*
[94] *Ibid Article 13*
[95] *Ibid, Article 9*
[96] *Ibid, Article 17*
[97] *Ibid, Article 18*

remedy, the City of Kigali or the District will remedy the situation and the cost shall borne by the owner[98]. An Order of the Minister determines notification modalities.

- *When it comes to violations of the provisions of this Law, the prescribed sanctions are administrative in nature, even though the Law does not elaborate what these 'administrative sanctions' are specifically. Such administrative sanctions are to be determined by an Order of the Minister.*

3.3 PRIME MINISTER'S INSTRUCTIONS AND MINISTERIAL ORDERS

3.3.1 Prime Minister's Instructions preventing air pollution caused by vehicular emissions[99]

These Prime Minister's Instructions were put in place in 2013 as an interim measure prior to the enactment and implementation of the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda. The instructions were intended to protect citizens by preventing air pollution caused by emissions from motor vehicles and machines that use petroleum products. The Instructions applied to cars for personal transport, commercial cars, motor cycles and machines using petroleum products and machines that use petroleum fuel as their source of energy.

Owners of vehicles and machines that use petroleum fuel as their source of energy were required by these Instructions to maintain them according to the best technical practices in order to keep them within the authorized emissions limits. The Ministries in charge of Environment, Transport, Finance & Economic Planning, and Internal Security were mandated with the implementation of these Instructions[100]. These instructions have since been overtaken by the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda.

3.3.2 Ministerial Order Preventing Activities that Pollute the Atmosphere[101]

This Ministerial Order was issued in 2010 pursuant to the Constitution of Rwanda and the Organic Law determining the modalities of protection, conservation and promotion of environment in Rwanda. The purpose of this Order was to prevent activities that have the

[98] *Ibid, Article 21*
[99] *Ibid, No. 005/03 of 27/12/2013*
[100] *Ibid, Article 12*
[101] *Republic of Rwanda, Ministerial Order No. 003/16.01, Official Gazette of 15/07/2010*

potential to pollute the atmosphere[102]. All activities that give rise to chemical pollutants listed in the annex to the Order are to be controlled in such a way that the pollutants do not exceed the prescribed quantity limits[103]. This Order has since been overtaken by the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda.

3.3.3 Ministerial Order Determining the Modalities of Environment Conservation in Mining and Quarry Extraction[104]

This Ministerial Order provides for the modalities of environmental conservation in mining and quarrying activities in Rwanda. Besides the requirement for environmental impact assessment[105] that must include aspects of air quality, the Order requires that during the period of construction as well as during mining and quarry extraction, every exploiter must transmit to the Ministry in charge of mines and quarries monthly reports with details on ways of managing every environmental impact identified in the study[106]

The monthly environmental report on air quality envisaged by this Order should include risks relating to dusts during the construction and extraction periods; discharge of gas from processing and smelting works and vehicles, which is harmful to health, or contributes to severe Greenhouse gas emission[107]. However, there doesn't seem to be in place a stringent monitoring and enforcement mechanism to ensure that the targeted entities submit the monthly reports regularly and in time, and that the reports contain all the required information. In addition, there is no clear coordination mechanism between the ministry in charge of mines on the one hand and that of environment and REMA on the other hand on how to deal with the monthly environmental reports.

3.3.4 Ministerial Order Relating to Air Pollutants Emission[108]

This Ministerial Order is meant to implement the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda determines the requirements relating to air pollutants emission; administrative sanctions for violationsof provisions of the law governing the preservation of air quality and prevention of air pollution in Rwanda.

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[102] *Ibid, Article 1*
[103] *Ibid, Article 2*
[104] *No. 004/Minifom/2010 of 14/09/2010 (Official Gazette No. 41 bis of 11/10/2010)*
[105] *Article 3*
[106] *Articles 7&8*
[107] *Article 11*
[108] *No. 02/2018 of 17/09/2018 (Official Gazette No. 39bis of 24/09/2018)*

3.4 STANDARDS

3.4.1 Rwanda Standard – Testing of Motor Vehicles for Roadworthiness[109]

This Standard was established in 2012 and covers the examination and testing for roadworthiness of all vehicles used on public roads. Besides mechanical soundness and roadworthiness, the initial version of the standard provided for smoke emission and exhaust system testing[110]. Upon inspection and testing under this standard, an examiner was required to reject a motor vehicle in any of the following circumstances:

- in the case of any type of engine, the exhaust smoke emission is so dense during a road test that it would, in the opinion of the examiner, hinder other road users, or the engine emits excessive smoke or fumes; or
- except in the case of slip joints on heavy vehicles where slight leaks are acceptable, the exhaust gas leaves the exhaust system by means other than through the silencer or muffling device, or the exhaust pipe or silencer is in such a position that oil or other flammable liquid; or
- material can drip or fall onto it, or is not in efficient working order, or is so placed and maintained that exhaust gas or smoke leaks into the driving cab or passenger compartment of the vehicle; or
- the exhaust system is within 25 mm of any hydraulic brake system pipe unless it has been properly insulated, or any exhaust gases are discharged onto any fuel container, fuel hose, spare wheel (if fitted), battery or any part of the brake system, or the exhaust system is not secure; or
- the exhaust system is positioned such that it can cause danger to pedestrians.

The initial draft of the standard, RS 741-1:2012, provided for the test method[111] and instruments[112] to be used in carrying out motor vehicles exhaust emission testing and outlined emission limits for vehicles and engines[113]. The categories of vehicles for which emission limits were set out included:

i) Emission standards for diesel fuelled passenger cars and light commercial vehicles[114];
ii) Emission standards for gasoline and LPG fuelled passenger cars and light commercial vehicles[115];
iii) Emission Standards for Heavy-Duty Engines[116].

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[109] Rwanda Bureau of Standards (2012), RS 145 -1:2012, First edition 2012-05-04
[110] The initial version of the standard was drafted as RS 741-1:2012 and provided for both mechanical roadworthiness and exhaust emission testing.
[111] Rwanda Bureau of Standards, RS 128:2009 EAS 545:2008 Road vehicles - Measurement methods for exhaust gas emissions during inspection or maintenance.
[112]Rwanda Bureau of Standards, RS 256:2009 EAS 578:2008 Instruments for measuring vehicle exhaust emissions.
[113] Annex A of the Standard
[114] Table 1 of Annex A
[115] Table 2 of Annex A

Table 7 below shows the set emission limits for diesel fuelled passenger cars and light commercial vehicles (N_1), g/km

Table 7: Emission limits for diesel passenger cars and light commercial vehicles

Vehicle Category	Date (Y/M)	CO	NOx + HC	NOx	PM	Reference
Light-Duty Vehicles GVWR						
Passenger Cars (M_1)	2011/09	0.64	0.56	0.50	0.05	Euro III
	2012/07	0.50	0.30	0.25	0.025	Euro IV
	2014/07	0.500	0.230	0.180	0.005	Euro V
LDV Class 1, RM ≤ 1305 kg	2011/09	0.64	0.56	0.50	0.05	Euro III
LDV Class 2, 1305 kg < RM ≤1760 kg		0.80	0.72	0.65	0.07	
LDV Class 3, RM > 1760 kg		0.95	0.86	0.78	0.10	
LDV Class 1, RM ≤ 1305 kg	2012/07	0.50	0.30	0.25	0.025	Euro IV
LDV Class 2, 1305 kg < RM ≤1760 kg	2013/07	0.63	0.39	0.33	0.04	
LDV Class 3, RM > 1760 kg		0.74	0.46	0.39	0.06	
LDV Class 1, RM ≤ 1305 kg	2014/07	0.500	0.230	0.180	0.005	Euro VI
LDV Class 2, 1305 kg < RM ≤1760 kg	2016/07	0.500	0.295	0.235	0.005	
LDV Class 3, RM > 1760 kg		0.500	0.350	0.280	0.005	
Medium-Duty Vehicles						
MDV Class 1, RM ≤1305	2011/09	0.64	0.56	0.50	0.05	Euro III
MDV Class 2, 1305 < RM ≤ 1760 kg		0.80	0.72	0.65	0.07	
MDV Class 3, RM> 1760 kg		0.95	0.86	0.78	0.10	
MDV Class 1, RM ≤1305	2012/07	0.50	0.30	0.25	0.025	Euro IV
MDV Class 2, 1305 < RM ≤ 1760 kg		0.63	0.39	0.33	0.04	
MDV Class 3, RM > 1760 kg		0.74	0.46	0.39	0.06	
MDV Class 1, RM ≤1305	2014/07	0.50	0.230	0.180	0.005	Euro V
MDV Class 2, 1305 < RM ≤ 1760 kg		0.63	0.295	0.235	0.005	
MDV Class 3, RM > 1760 kg		0.74	0.350	0.280	0.005	

Source: RBS RS 741-1:2012, first edition

Table 8 below shows the set emission limits for gasoline and LPG fuelled passenger cars and light commercial vehicles (N_1), g/km

[116] *Table 3 of Annex A*

Table 8: Emission limits for gasoline and LPG passenger cars and light commercial vehicles

Vehicle Category	Date (Y/M)	CO	HC	NOx	Reference
Passenger Cars	2011/09	2.3	0.20	0.15	Euro III
	2012/07	1.00	0.10	0.08	Euro IV
Light Commercial Vehicles					
Light-Duty Vehicles					
LDV Class 1, RM ≤ 1305 kg	2011/09	2.3	0.20	0.15	Euro III
LDV Class 2, 1305 < RM ≤ 1760 kg		4.17	0.25	0.18	
LDV Class 3, RM > 1760 kg		5.22	0.29	0.21	
LDV Class 1, RM ≤ 1305 kg	2012/07	1.00	0.10	0.08	Euro IV
LDV Class 2, 1305 < RM ≤ 1760 kg		1.81	0.13	0.10	
LDV Class 3, RW > 1760 kg		2.27	0.16	0.11	
Medium-Duty Vehicles					
MDV Class 1, RW ≤ 1305 kg	2011/09	2.3	0.20	0.15	Euro III
MDV Class 2, 1305 kg < RW ≤ 1760 kg		4.17	0.25	0.18	
MDV Class 3, RM > 1760 kg		5.22	0.29	0.21	
MDV Class 1, RM ≤ 1305 kg	2013/07	1.00	0.10	0.08	Euro IV
MDV Class 2, 1305 kg < RM ≤ 1760 kg		1.81	0.13	0.10	
MDV Class 3, RM > 1760 kg		2.27	0.16	0.11	

Source: RBS RS 741-1:2012, first edition

Table 9 below shows the set emission limits for heavy duty engines.

Table 9: Emission limits for heavy duty engines.

Date (Y/M)	CO	HC	NOx	PM	Smoke in m^{-1}	Unit	Test	Reference
Diesel (N_2, N_3 & O), GVW ≥ 3500 kg								
2011/09	2.1	0.66	5.0	0.10 (0.13*)	0.8	g/kWh	ESC	Euro III
2013/01	1.5	0.46	3.5	0.02	0.5	g/kWh	ESC	Euro IV
2015/01	1.5	0.46	2.0	0.02	0.5	g/kWh	ESC	Euro V
Large Passenger car (GVW >2.5t Gasoline) and other Heavy - Duty Gasoline Vehicles								
Date (Y/M)	**CO**	**HC**	**NOx**	**PM**	**Smoke in m^{-1}**	**Unit**	**Test**	**Reference**
2011/09	5.22	0.29	0.21	-	-	g/km	-	Euro III
2013/07	2.27	0.16	0.11	-	-	g/km	-	Euro IV
Large Passenger car (GVW >2.5t Diesel)								
Date (Y/M)	**CO**	**HC + NOx**	**NOx**	**PM**	**Smoke in m^{-1}**	**Unit**	**Test**	**Reference**
2011/09	0.95	0.86	0.78	0.10	-	g/km	-	Euro III
2013/07	0.74	0.46	0.39	0.06	-	g/km	-	Euro IV
	* for engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 min^{-1}							

Source: RBS RS 741-1:2012, first edition

3.4 .2 Rwanda Standard – Emissions to the Air by Cement Factories – Guidelines[117]

This Rwanda Standard was adopted from and is similar to the first edition of the East Africa Community regional Standard EAS 750/2010, Air quality — Emissions to the air by cement factories — Guidelines. This East African Standard not only lists the commonly encountered pollutants in cement factories but also gives the reasons behind these emissions and gives possible options of mitigation. The main air pollutants covered by this standard are:

i) PM
ii) Oxides of Nitrogen (NO_x) and other nitrogen compounds
iii) Sulphur dioxide (SO_2) and other sulphur compounds.

Whereas cement manufacturing is associated with additional pollutants besides the three listed above (e.g. carbon monoxide (CO), volatile organic compounds (VOCs), polychlorinated

[117] Rwanda Bureau of Standards, RS EAS 750 2010

dibenzodioxins and dibenzofurans (PCDD and PCDF), metals and their compounds, HF & HCl and carbon dioxide (CO_2), at the moment this EAC standards only prescribe emission guidelines for the three main pollutants only i.e. dust, NO_x and SO_2. However, the actual emission limits are prescribed in a separate East African Standard, CD/T/67/2007, Tolerance limits of emissions discharged to the air by cement factories.

A reading of the standard reveals that the set limits for SO_2 assume that:

- *The cement factories are not using raw material with high sulphur content; and that*
- *None of the cement factories have or make use of modern abatement techniques such as absorbent addition, wet or dry scrubber, etc.*

The implication of the above assumptions is that even without modern abatement techniques, the factories should be able to meet the standard as long as they use raw materials with low sulphur content. Alternatively, if they must use high sulphur content raw materials then they should put in place the modern abatement techniques to control the SO_2 emissions.

3.4.3 Rwanda Standard – Tolerance limits of emissions discharged to the air by factories[118]

This Rwanda Standard was adopted from and is similar to the first edition of the East Africa Community regional standard EAS 752/2010 Air quality – Tolerance limits of emission discharged to the air by factories. The standard specifies the tolerance limits of PM, NO_x and SO_2 emissions from factories of all kinds, including cement factories.

During this assessment, it was pointed out by REMA and RSB that some industries, especially thermal power plants, have registered inability to meet the prescribed emission limits, especially for SO_2, and NO_X. This issue was also pointed out in the recent REMA report – Inventory of Sources of Air Pollution in Rwanda – where it was noted that the EAC standards which Rwanda adopted have inconsistencies that make them impossible to implement. The report has recommended the development of Rwanda specific standards, and in the case of thermal power plants, specific emission limits for SO_2 and NO_X have been recommended.

[118] Rwanda Bureau of Standards, RS EAS 752 2010

3.4.4 Rwanda Standard – Air Quality Specification[119]

This Rwanda Standard was adopted from and is similar to the first edition of the East Africa Community regional standard EAS 751/2010 Air quality – Specification. The Standard outlines permissible limits of some common air pollutants, namely sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM), oxides of nitrogen (NO_x), hydrocarbons (HC), and lead (Pb). The standard gives imission limits[120] applicable to the ambient air and emission limits[121] applicable to emission sources.

3.4.5 Rwanda Standard – Automotive Gasoline (Premium Motor Spirit) Specification[122]

This Rwanda Standard was adopted from and is similar to the first edition of the East Africa Community regional standard RS EAS 158:2012 - Automotive Gasoline (Premium Motor Spirit) Specification. It stipulates specifications for gasoline and petrol. On fuel quality, standard specifies the maximum lead level in gasoline at 13.0 g/L and maximum sulphur level at 0.015% m/m (150 ppm). The standard allows additives to improve fuel performance provided there are no known harmful side effects, there is no deterioration of drivability and emission control durability is not compromised.

3.4.6 Rwanda Standard – Automotive Gas Oil (Automotive Diesel) Specification[123]

This is also an East African Community (EAC) standard. It specifies requirements and methods of sampling and testing for automotive diesel as manufactured, stored, transported and marketed.

On fuel quality, the standard specifies the maximum requirement of diesel fuels sulphur content at 50mg/kg (effective January 1, 2015), polycyclic aromatic hydrocarbons (PAH) at 11% by volume, carbon residue at 0.15% (m/m), and ash content at 0.01% (m/m). The standard also allows additives to improve fuel performance provided there are no known harmful side effects, there is no deterioration of drivability and emission control durability is not compromised.

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[119] Rwanda Bureau of Standards, RS EAS 751 2010
[120] Imission limit refers to the highest permissible weight concentration of pollutants contained in the air.
[121] Emission limit refers to the highest permissible quantity of pollutants released into the air from a pollution source.
[122] Rwanda Bureau of Standards, RS EAS 158:2012
[123] Rwanda Bureau of Standards, RS EAS 177:2012

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

This section outlines the conclusions and key policy recommendations arising from the Kigali City Air Quality Policy and Regulatory Situational Analysis.

4.1 CONCLUSIONS

1. General Policy and Regulatory Landscape for Air Quality Management

Rwanda's current policy and regulatory landscape has a wide array of instruments aimed at ensuring clean air for all. The Constitution of Rwanda provides a good foundation for air quality management by guaranteeing everyone the right to a clean and healthy environment, and the right to good health. There are also in place several policies, laws, Ministerial Orders, standards, guidelines and strategies that provide for different aspects of air quality management for different sectors. Some of these policy and regulatory instruments require updating, while others just need to be implemented and enforced effectively. Nevertheless, Rwanda is on a good path to ensuring cleaner air for the country generally and for Kigali City in particular.

2. Air Quality Standards

The Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda requires the Rwanda Standards Board to establish specific air quality standards including: ambient air quality standards, occupational air quality standards; quality standards that regulate emissions of air pollutants from different sources such as industries, motor vehicles, etc. Whereas some of these standards are already in place, the 2018 REMA report – *Inventory of Sources of Air Pollution in Rwanda* – has recommended their revision and updating in order to make them more relevant and applicable to Rwanda's situation.

3. Air Pollution from Industrial Sources

Rwanda adopted East Africa Community (EAC) regional standards for tolerance limits of emissions discharged to the air by factories. The standard specifies the tolerance limits of PM, NO_x and SO_2 emissions from factories of all kinds, including cement factories. However, the 2018 REMA report – *Inventory of Sources of Air Pollution in Rwanda* – has pointed out

inconsistencies in these standards that have made it impossible to implement, especially for Rwanda's small capacity power plants. This necessitates the revision and updating of the existing standards.

4. Vehicle Exhaust Emissions

Rwanda's standards for testing of motor vehicles for road worthiness currently do not have provisions for vehicle emission testing. Previous attempts to put in place vehicle emission standards have been unsuccessful. However, despite there being no legally enforceable national standard for vehicle emissions, there is mandatory periodic emission testing for all motor vehicles in Rwanda. Current target values for vehicle emissions are based on the manufacturer's default settings in the test equipment at the inspection centre and this determines pass or fail results. In addition, despite motor cycles being key contributors to overall transport related air pollution in Rwanda, especially in Kigali City, the current emissions testing infrastructure in the country have no facilities for testing and inspection of motor cycles.

5. Compliance & Enforcement

Capacity for enforcement of air quality policies and regulatory instruments exist within various institutions but is constrained due to several reasons including the following:

- Relevant institutions do not have sufficient resources (qualified staff, skill, equipment, laboratories, finances, etc.) to effectively carry out air quality monitoring activities and enforcement;
- Most of the established air quality related standards lack clear implementation guidelines hence difficult to implement and enforce;
- Coordination mechanisms between various governmental enforcement agencies is not well structured;
- Low awareness of air pollution and its impacts among the public and key policy maker.

4.2 POLICY RECOMMENDATIONS

The following are the key policy recommendations of the Kigali City Air Quality Policy and Regulatory Situational Analysis, ranked in order of priority by stakeholders during the validation workshop in Kigali on 8th November 2018:

Gap/area of intervention	Short Term (1-2 yrs.)	Medium Term (3-5 yrs.)	Long term (>5yrs)
General policy landscape	▪ *Update existing policy and regulatory instruments where necessary, and develop new instruments where they do not exist, e.g. there is need to put in place all relevant standards and ministerial orders to implement the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda.* ▪ *Enhance specific sector actions to control air pollution across all sectors.*	▪ *Enhance coordination between relevant regulatory agencies e.g. REMA, RNP, CoK, Districts, etc.*	▪ *Fully implement existing policy and regulatory instruments.* ▪ *Continually strengthen and update environmental policies, regulatory frameworks and public institutions responsible for environmental protection and natural resources management.*
Air Quality Standards	▪ *Develop new Rwanda air quality standards or review and update existing standards to make them applicable to Rwanda's economic situation.*	▪ *Strengthen the monitoring and enforcement capacity of REMA and other relevant environmental regulators.*	▪ *Continually improve air quality standards and strengthen institutions responsible for environmental protection and natural resources management.*
Air Pollution from Industrial Sources	▪ *Develop Rwanda specific standards and, in the case of thermal power plants, the limits for SO_2 and NO_X that have been recommended in*	▪ *Strengthen the monitoring and enforcement capacity of REMA and other relevant environmental regulators.*	▪ *Provide economic incentives for industries that invest in air pollution control systems* ▪ *Promote cleaner production and resource efficiency in all industries*

	the REMA 2018 Inventory of Sources of Air Pollution in Rwanda report should be adopted as the applicable Rwanda standards.		
Vehicle exhaust emissions	▪ *Develop vehicle emission standards to provide emission limits for new vehicles, imported used vehicles and on-road vehicles of different categories and fuel types.* ▪ *These standards should prescribe emission limits for motor vehicles, motor cycles, motor tricycles and non-road mobile machinery such as tractors and earth movers.*	▪ *Enhance and upgrade the existing infrastructure for vehicle inspection, and testing.* ▪ *Expand the emission testing and inspection facilities to provide dedicated lanes for motor cycles in order to cope with their large numbers in Rwanda.*	▪ *Establish an age restriction on imported used vehicles.* ▪ *Provide incentives for purchase of new vehicles and/or investment in cleaner vehicle technologies.* ▪ *Implement a scrappage programme for old polluting vehicles*
Compliance & enforcement	▪ *Carry out an aggressive education and awareness campaign on air quality management in order to obtain the support of policy makers and the public on current and future air quality interventions* ▪ *Develop clear guidance for the regulated community on what they must do to comply with existing air quality policies, laws, regulations and standards.* ▪ *Develop clear guidance for enforcement officials on what they must do to enforce compliance.*	▪ *Strengthen the monitoring and enforcement capacity of relevant institutions* such as *REMA, COK, Districts, National Police, etc.* ▪ *Establish clear inter-agency coordination mechanisms to ensure effective implementation of air quality interventions.*	▪ *Continuously improve the monitoring and enforcement capacity of relevant institutions such as REMA, RNP, CoK, Districts, etc.*