



**CLIMATE &  
CLEAN AIR  
COALITION**  
TO REDUCE SHORT-LIVED  
CLIMATE POLLUTANTS



**Ministry of Environment**



**Rwanda Standards Board**

## **Rapid situational assessment: Towards developing/revising air quality (internal combustion engine emission) standards for Rwanda**



*Report prepared for Ministry of Environment and Rwanda Standards Board by:*



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## EXECUTIVE SUMMARY

This rapid situational assessment report has been prepared as part of technical support by the Climate and Clean Air Coalition (CCAC) to the Government of Rwanda to review its air quality standards and if possible develop new emission standards for internal combustion engines. CCAC's support follows a request by Rwanda's Ministry of Environment (MOE) for technical support to assist Rwanda Standards Board (RSB) to review and develop new air quality standards (internal combustion engine emission standards). It is upon these standards that enforcement activities against air pollution will be based and checked within the framework of Rwanda's existing laws & regulations.

The objective of the situational assessment was to obtain a better understanding of Rwanda's situation as relates to air pollution from different kinds of internal combustion engines; and current policy and regulatory frameworks and emission testing infrastructure, in order to recommend appropriate emission standards and limits that are applicable to Rwanda's situation.

The report was developed by the Environmental Compliance Institute (ECI), CCAC's technical partner for the project, and includes information gathered through a detailed desktop review of relevant documents as well as key informant interviews conducted with officials of key Rwanda Government ministries and agencies including: Ministry of Environment, Ministry of Infrastructure, Rwanda Environment Management Authority, Rwanda National Police (Motor Vehicle Inspection Centre), Rwanda Revenue Authority and Rwanda Standards Board.

The main findings and recommendations of the situational analysis are summarized below:

- ***Rwanda's current policy, legal and regulatory framework envisages control of air pollution and has sufficient provisions to anchor the proposed technical standards and permissible limits for motor vehicle emissions as well as emissions from other types of engine operated machines and equipment.*** Rwanda Standards Board is mandated by law to establish quality standards that regulate emissions of air pollutants from different sources contributing to air pollution.
- There have been previous attempts to put in place Rwanda national standards for emissions from motor vehicles. These standards were initially part of the Rwanda Standard for Testing of Motor Vehicles for Roadworthiness but were deleted/repealed due to difficulties in implementation. This assessment established that the said standards were an adoption of a range of Euro Standards – from Euro 3/III to Euro 6/VI and were mainly certification standards for new (off-factory) vehicles hence could not apply to motor vehicles already on the road in Rwanda, majority of which are imported used vehicles. ***It is therefore necessary to develop new Rwanda Standards that will apply to new vehicles (off-factory, whether imported or locally assembled) and separate standards for on-road vehicles (in-use, including imported used vehicles), depending on year of manufacture.***
- Despite existing mandatory periodic emission testing for motor vehicles in Rwanda, there is no legally enforceable national standard in place against which the tests are carried out. Current target values for vehicle emissions are based on the manufacturer's default settings in the test

equipment. ***There is an urgent need to put in place a national standard and to re-calibrate the test equipment against the set national standard.***

- Despite motor cycles being key contributors to overall transport related air pollution in Rwanda, especially in Kigali City, the current mandatory requirement for motor vehicle emissions testing does not cover motorcycles. In addition, the emission testing equipment in the country are few and may not cope with the large numbers of motor cycles in the country. ***In order to control the rising air pollution from motor cycles, it is recommended that the proposed new standards should include emission limits for motor cycles, and that regulations be put in place to require periodic emission testing for motor cycles. There will also be need to expand the emission testing and inspection facilities to provide dedicated lanes for motor cycles in order to cope with their large numbers in Rwanda.***
- Rwanda's existing emission testing and inspection equipment for vehicle emissions has the capability to measure HC, CO, CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub> (option), K value, turbidity, and PM mass concentration. Even though the equipment is currently calibrated to measure all the above parameters except NO<sub>x</sub>, turbidity, and PM mass concentration, it is possible to re-calibrate it to also measure the missing parameters if need be, and also to set the equipment to measure against new target values (lower or higher) as may be required by the proposed national standards. ***Therefore, other than for expansion purposes, the new standards will not require investment in new equipment but will only require re-calibration of the existing equipment.*** There is in place a standing agreement with the equipment manufacturer for annual service and maintenance as well as emergency back-up. The re-calibration can therefore be arranged with the manufacturer.
- East African Community (EAC) standards which Rwanda adopted for emission limits for thermal power plants have inconsistencies that make them impossible to implement, especially for Rwanda's small capacity power plants. ***A recent REMA report – Inventory of Sources of Air Pollution in Rwanda – has recommended the development of Rwanda specific standards, and in the case of thermal power plants, specific emission limits for different pollutants have been proposed in the report, based on the current World Bank/IFC Emission Guidelines for Thermal Power Plants. This report recommends the adoption of the proposed limits in the REMA report as the new Rwanda standard.***
- For non-road mobile machinery (including construction and agricultural machinery), engine run hand held equipment and generators, there are currently no Rwanda standards or emission limits in place. Whereas in a few developed countries e.g. UK there is in place in-use emission limits for some of these equipment, majority of countries only have certification standards for new equipment. This is because of the often few numbers of these kinds of equipment and/or their sparse distribution mostly in the country side with generally low and localized impact on air quality. In addition, testing infrastructure for in-use NRMM, engine run hand held equipment and generators does not exist in most countries, just like in Rwanda. ***It is therefore recommended that Rwanda only develops certification standards for new equipment, based on***



*international best practice that can easily be enforced through a regulation requiring that the equipment be accompanied by a certificate of conformance at the time of import (noting that Rwanda mainly imports but does not manufacture any of this equipment).*

- *In terms of approach for the new standards, it is recommended that where standards already exist e.g. on emissions from factories, instead of re-inventing the wheel by drafting a whole set of documents, it will be more efficient to review the current limits in the schedules, especially the EAC limits, for example for power plants, and replace them with new schedules with Rwanda specific limits. As for motor vehicle emissions, it is also proposed to develop schedules for emission limits that will be added to the current standards for inspection of motor vehicles for road worthiness in line with the Prime Minister's Instructions preventing air pollution caused by vehicular emissions. In the case of non-road mobile machinery e.g. construction equipment and agricultural machinery, as well as generators, it is proposed set up a new set of standards.*
- *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.***

## CHAPTER ONE

### 1.0 COUNTRY BACKGROUND

#### *1.1 Location, size and administrative system of Rwanda*

Rwanda is a landlocked country located in central- east Africa within the African Great Lakes region, with Kigali as its capital city. The country is bordered by Burundi, Democratic Republic of Congo, Tanzania and Uganda. Rwanda covers an area of 26,388 km<sup>2</sup> and it is the world's 149<sup>th</sup> largest and Africa's 4<sup>th</sup> smallest country<sup>1</sup>.

Rwanda has two levels of government – central and local government. The provincial administrative regions form the central government. Rwanda is divided into five provinces, namely: Northern Province, Southern Province, Eastern Province, Western Province, and the City of Kigali. Each province is divided into districts. Each district is in turn divided into sectors, which are in turn divided into *cells*, which are in turn divided into *villages*. The local government comprises of the lower administrative units made up of 30 districts, 416 sectors, 2,148 cells and 14,837 villages.

Figure 1 below shows the location map of Rwanda in Africa, while figure 2 shows the administrative map of Rwanda.

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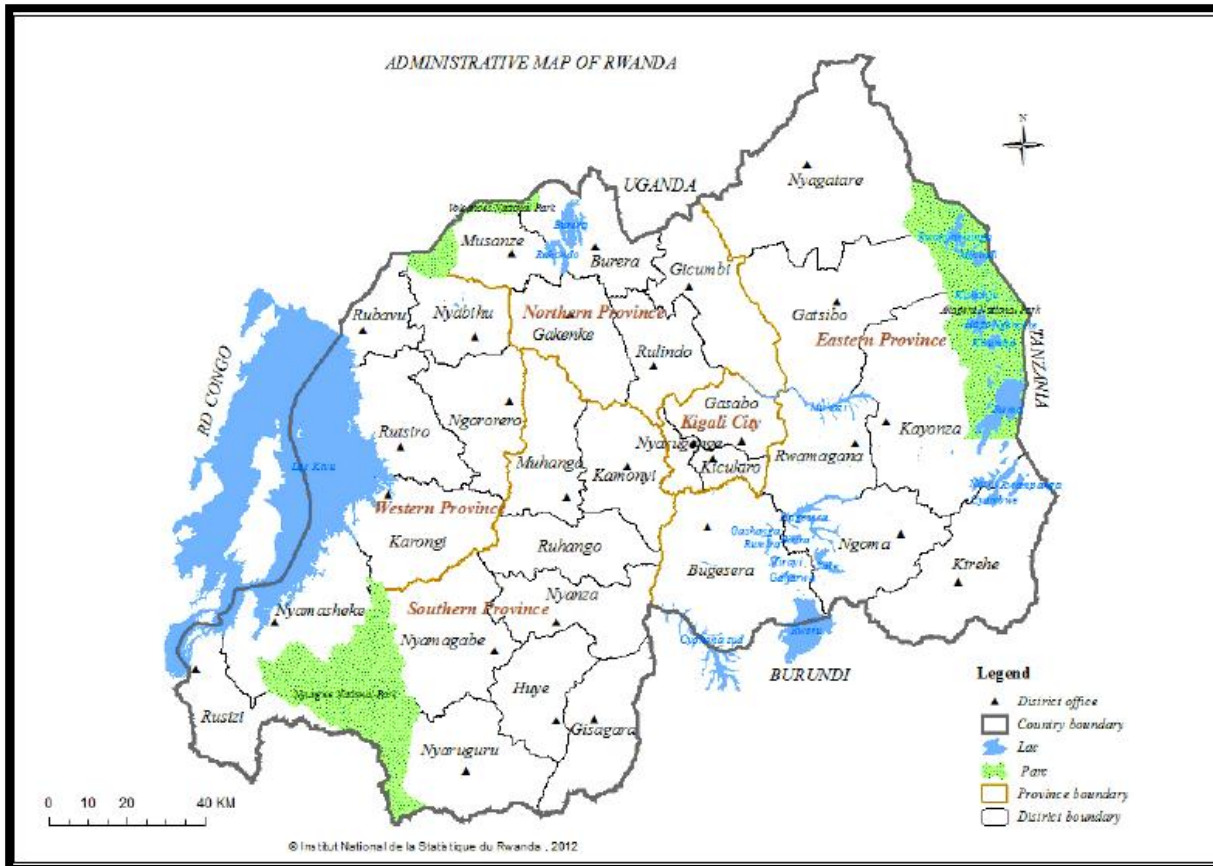
<sup>1</sup> World Bank Group, Rwanda Country Survey, 2016.

Figure 1: Location Map of Rwanda



Source: World Atlas, 2018

**Figure 2: Administrative map of Rwanda**



Source: Rwanda National Institute of Statistics, 2012

### **1.2 Climate and Topography**

Whereas Rwanda is located within the equatorial belt, it does not typically exhibit the strict equatorial rainy climate. It has a modified humid climate with elements of rain forests and Savannah types. The central and eastern part of the country is generally of semi-arid type owing to its position in the rainy shadow of the western highlands<sup>2</sup>.

Rwanda experiences a bimodal pattern of rainfall, which is driven primarily by the progression of the Inter-Tropical Convergence Zone (ITCZ). The rainfall characteristics for Rwanda are known to exhibit large temporal and spatial variation due to varied topography and existence of large water bodies near the country. However, two rainy seasons are generally distinguishable, one centered around March – May and the other around October – December. The annual average rainfall is 800mm<sup>3</sup>.

<sup>2</sup> Rwanda Meteorology Agency, Climatology of Rwanda, 2018

<sup>3</sup> Ibid

The warmest annual average temperatures are found in the eastern low lying areas (20 - 21°C) and Bugarama Valley (23 - 24°C), and cooler temperatures in higher elevations of the central plateau (17.5 - 19°C) and highlands (less than 17°C). Temperatures vary little throughout the year.<sup>4</sup>

Rwanda's altitude is generally high throughout the country with the lowest point being in Rusizi River at 950 metres above sea level while the highest peaks are found in the Virunga volcano chain in the northwest with Mount Karisimbi being Rwanda's highest point at 4,507 metres above sea level. The western part of Rwanda has an elevation of 1,500 metres to 2,500 metres. The central part of the country is predominantly rolling hills, while the eastern border region consists of Savannah plains and swamps.

### **1.3 Population**

Rwanda's population was 10.5 million people as per the country's 2012 census but grew to 11.9 million people by 2016 and is projected to increase to 12 million by end of 2018<sup>5</sup>. The country's population density stands at 474 people per km<sup>2</sup> in 2018<sup>6</sup>. Rwanda's population is relatively young with the 2012 census results placing 43.3% of the population at 15 years and under while 53.4% of the population is between 16 years and 64 years. The annual birth rate in Rwanda stands at 30.7 births per 1000 people, death rates at 6.4 deaths per 1000 people while average life expectancy is at 64.3 years. The country's sex ratio is even<sup>7</sup>.

70.22% of Rwanda's population is rural based while the urban population stands at 29.78%. Kigali City holds the bulk of the urban population, standing at approximately 1 million residents, while the rest of the urban population is spread across other growing towns and cities such as Huye, Rubavu, Muhanga, and Musanze, with each having slightly less than 100,000 people<sup>8</sup>.

### **1.4 Socio-economic context**

Rwanda met most of the Millennium Development Goals (MDGs) by the end of 2015. This saw strong economic growth that resulted in significant improvements in living standards, with a two-thirds drop in child mortality and near-universal primary school enrolment. The poverty rate dropped from 44% in 2011 to 39% in 2014, while inequality measured by the Gini coefficient fell from 0.49 to 0.45<sup>9</sup>.

Rwanda's long-term development goals are outlined in the country's Vision 2020<sup>10</sup>, a strategy that seeks to transform the country from a low-income, agriculture-based economy to a knowledge-based, service-oriented economy with middle-income country status by 2020. In order to achieve this, the Government of Rwanda has come up with a medium-term strategy – the second Economic

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<sup>4</sup> Ibid

<sup>5</sup> United Nations, Department of Economic and Social Affairs, Population Division, World Population Prospects: The 2017 Revision, Methodology of the United Nations Population Estimates and Projections, Working Paper No. ESA/P/WP.250. New York: United Nations.

<sup>6</sup> World Population Review, 2018

<sup>7</sup> CIA, The World Fact Book, 2018

<sup>8</sup> World Bank Open Data, 2018

<sup>9</sup> World Economic Forum, 5 things to know about Rwanda, 2017

<sup>10</sup> Government of Rwanda, Ministry of Finance & Economic Planning, 2000

Development and Poverty Reduction Strategy (EDPRS 2)<sup>11</sup> which outlines its overarching goal of growth acceleration and poverty reduction through four thematic areas: economic transformation, rural development, productivity and youth employment, and accountable governance. The EDPRS 2 aims to: raise gross domestic product (GDP) per capita to \$1,000; reduce the percentage of the population living below the poverty line to less than 30%; and reduce the percentage of the population living in extreme poverty to less than 9%.

These goals build on commendable development successes over the last decade that include high growth, rapid poverty reduction and reduced inequality. Rwanda is today one of the fastest growing economies in Africa. The country's real GDP growth was averaged at about 8.9% per annum between 2001- 2015 but experienced some decline to about 5.9% in 2016<sup>12</sup>. However it recovered in 2017 averaging at 6.1%. In the first quarter of 2018, estimates show that GDP growth was 10.6 % higher in real terms compared to the same quarter of 2017<sup>13</sup>.

The primary sector is the backbone of Rwanda's economy, with three-quarters of the population employed in agricultural activity. The country's fertile soil allows for the production of diverse crops, including coffee, tea, bananas, beans, sorghum and potatoes. The secondary sector is small and counts construction as its largest component. The tertiary/service sector is also becoming a major area of focus for economic diversification away from agriculture, with the country aiming to become a technological leader on the continent.<sup>14</sup>.

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<sup>11</sup> Government of Rwanda, Ministry of Finance and Economic Planning, 2013

<sup>12</sup> World Bank Group, Rwanda Economic Update: Sustaining Growth by Building on Emerging Export Opportunities, 10<sup>th</sup> ed., 2017

<sup>13</sup> National Institute of Statistics Rwanda, GDP National Accounts, First Quarter 2018

<sup>14</sup> KPMG, Rwanda Economic Snapshot, 2017

## CHAPTER TWO

### 2.0 SECTOR EMISSION PROFILES

This Chapter discusses the emission profiles of the key sectors where fossil fuel run internal combustion engines are mostly used in Rwanda, including: transportation, energy, construction and agriculture.

#### 2.1 Transport Sector

##### 2.1.1 Motor Vehicles

###### *a. Vehicular emissions*

The transport sector remains the main source of urban air pollution in most countries, especially in developing countries and countries with economies in transition such as Rwanda, contributing up to 80% of urban air pollution in some cities<sup>15</sup>. The transport sector in Rwanda is wholly dependent on imported petroleum fuel and consumes approximately 75% of all petroleum products imported into the country.

A recent study conducted in Rwanda has revealed that older vehicles emit higher levels of NO<sub>x</sub> and PM<sub>10</sub> than newer vehicles and contribute more than 50% of total emissions. According to this study, vehicles made before the year 1999 contributed 58% of NO<sub>x</sub> and 66% of PM<sub>10</sub> emissions<sup>16</sup>. The increasing number of motor vehicles in Rwanda, particularly in Kigali City will therefore exacerbate the problem of air pollution if emissions from this sector are not controlled.

Emissions from the vehicles can be attributed to many factors including age, frequency of maintenance, fuel quality, weather and road conditions as well as vehicle speed among others. Studies have for instance shown that slower speeds (<30 km/h) with increased phases of acceleration and deceleration have larger emission factors compared to higher cruising speeds<sup>17</sup>.

Generally, vehicle emission rate is affected by:

- i. Vehicle type: larger vehicles tend to produce more emissions.
- ii. Vehicle age and condition: Older vehicles have less effective emission control systems. Vehicles with faulty emission control systems have high emissions.
- iii. Driving cycle: Emission rates tend to be relatively high when engines are cold.
- iv. Driving style: Faster accelerations tend to increase emission rates.
- v. Driving conditions: Emissions per mile increase under hilly and stop-and-go conditions, and at low and high speed.

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<sup>15</sup> PCFV, Regulatory Toolkit for Clean Fuels and Vehicles, 2015

<sup>16</sup> REMA, Inventory of Sources of Air Pollution in Rwanda: Determination of Future Trends and Development of National Air Quality Control Strategy, 2018.

<sup>17</sup> REMA, A Study on Air Pollution in Rwanda with Reference to Kigali City and Vehicular Emissions, 2011

Table I below is summary of different motor vehicle emissions and related impacts.

**Table I: Vehicle emissions and effects**

Emission	Description	Sources	Harmful Effects	Scale
<b>Carbon dioxide (CO<sub>2</sub>)</b>	Colourless and odourless gas	Fuel production and tailpipes.	Climate change	Global
<b>Carbon monoxide (CO)</b>	A toxic gas caused by incomplete combustion.	Tailpipes	Human health, climate change	Very local
<b>Nitrogen oxides (NO<sub>x</sub>) and Nitrous oxide (N<sub>2</sub>O)</b>	Various compounds, some are toxic, all contribute to tropospheric ozone.	Tailpipes	Human health, ozone precursor, ecological damage	Local and Regional
<b>Ozone (O<sub>3</sub>)</b>	Major urban air pollutant caused by reaction of NO <sub>x</sub> and VOCs c in sunlight.	NO <sub>x</sub> and VOC	Human health, plants, aesthetics	Regional
<b>Sulphur oxides (SO<sub>x</sub>)</b>	Lung irritant and acid rain	Diesel vehicle tailpipes	Human health and ecological damage	Local and Regional
<b>Volatile organic hydrocarbons (VOH)</b>	Various hydrocarbon (HC) gases	Fuel production, storage & tailpipes	Human health, ozone precursor.	Local and Regional
<b>Toxics (Ex: Benzene)</b>	Toxic and carcinogenic VOCs	Fuel production and tailpipes.	Human health, aesthetics	Very local
<b>Road dust (non-tailpipe particulates)</b>	Dust particles created by vehicle movement.	Vehicle use, brake linings, tire wear	Human health, aesthetics.	Local
<b>Fine particulates (PM<sub>10</sub>; PM<sub>2.5</sub>)</b>	Inhalable particles	Tailpipes, brake lining, road dust, etc.	Human health, aesthetics.	Local and Regional

Source: REMA, Study on Air Pollution in Rwanda with Reference to Kigali City and Vehicular Emission, 2011



## **b. Vehicle population in Rwanda**

Rwanda had a total of 92,135 registered motor vehicles as of 2017 (excluding motorcycles and three wheelers/auto rick shaws) an increase from 86,758 in 2016<sup>18</sup>. This is approximately 3% of the total motor vehicle fleet in the East Africa sub-region. Of this number, new vehicles accounts for only 15% with imported used vehicles accounting for 85 %<sup>19</sup>. As already pointed out in part (a) above, older vehicles emit higher levels of NO<sub>x</sub> and PM<sub>10</sub> than new modern vehicles contributing more than 50% of total emissions in Rwanda.<sup>20</sup>

Table 2 below shows the number and type of vehicles registered in Rwanda (excluding motorcycles), banded in different time periods up to 2017.

**Table 2: Number of vehicles registered in Rwanda by period of registration**

Vehicle Type	Number and year of registered vehicles in Rwanda				
	Up to 1999	2000-2005	2006-2011	2012-2017	Total
Car	26,590	6,165	1,130	493	34, 378
Pick Up	9,858	2,411	3,152	2,282	17,703
Artic HGV	516	107	343	204	1,170
Jeep	7,365	7,780	5,439	3,089	23,673
Minibus	4,572	906	562	285	6,325
Microbus	297	512	36	22	867
Rigid HGV	2,853	872	1,404	1,482	6,611
Bus	232	155	398	623	1,408
Total	52,283	18908	12464	8480	92135

Source: Rwanda Revenue Authority/REMA, 2018

\* Artic HGV = Articulated Heavy Goods Vehicle and is equivalent to a ‘half-trailer’ and ‘trailer; HGV = Heavy Goods Vehicle and is equivalent to a ‘truck’.

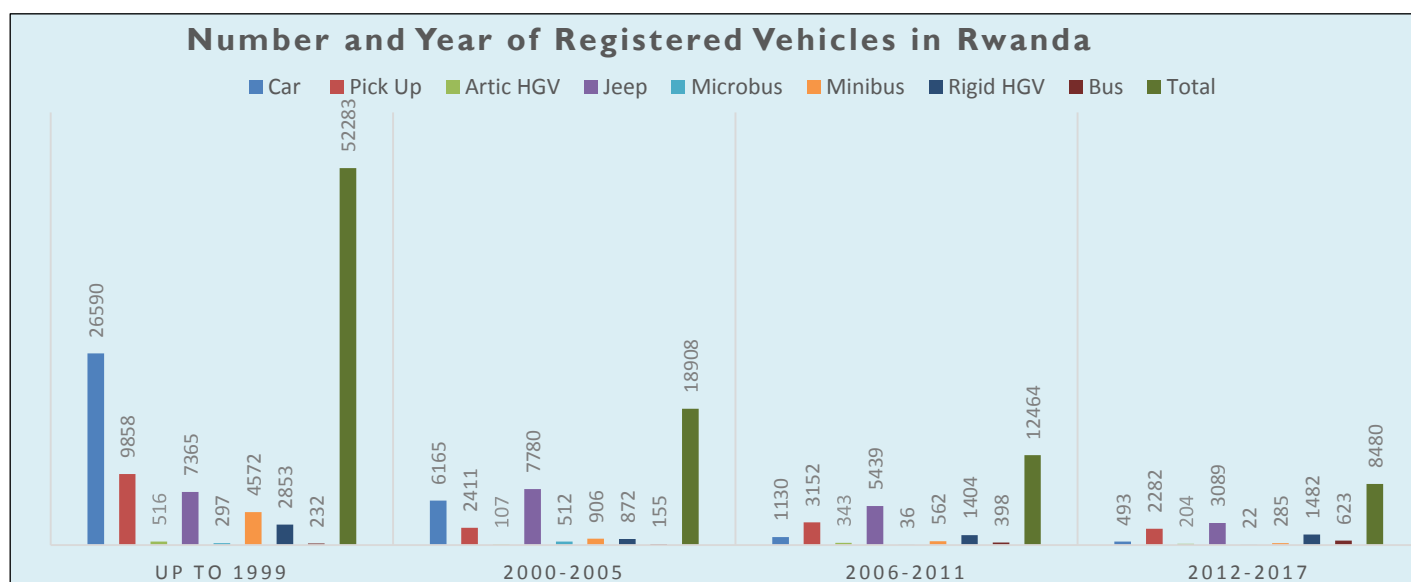
Figure 3 below shows the trend of vehicle registration in Rwanda up to 2017 as generated from the data in Table 2 above.

<sup>18</sup> National Institute of Statistics of Rwanda, Statistical Year Book, 2017

<sup>19</sup> UNEP, Paper on review of global trade in used vehicles, 2017

<sup>20</sup> REMA, 2018.

**Figure 3: Trend in vehicle registration by type in Rwanda**



Source: Generated from Rwanda Revenue Authority data, 2018

### **c. Age limit for imported vehicles in Rwanda**

Rwanda is among over 20 countries in Africa that do not have any age restriction on the import of used vehicles. Currently, about 95 % of vehicles in Rwanda are more than 10 years old, mostly manufactured before 2005<sup>21</sup>. However, there are on-going negotiations within the East Africa Community (EAC), of which Rwanda is a member, to restrict the age limit of imported used vehicles to at least 5 years by the year 2021 in order to promote local vehicle assembly in the sub-region<sup>22</sup>.

Table 3 below gives an overview of age limits by African countries that had set age limits for imported used vehicles as of 2017.

<sup>21</sup> Ibid foot note 16

<sup>22</sup> So far no agreement has been reached on setting a common age limit for importation of used vehicles in the EAC sub-region.

**Table 3: Examples of age limit restrictions on imported used vehicles by African countries**

Age Restriction	Countries
3 Years	Mauritius, Seychelles, Algeria, Chad,
4 Years	Gabon, Senegal
5 Years	Libya, Mozambique, Niger, Tunisia
7 Years	Cote d'Ivoire
8 Years	Kenya, Mauritania, Namibia
10 Years	Eritrea, Benin, Democratic Republic of Congo
12 Years	Liberia, Swaziland, Nigeria

Source: UNEP, Paper on review of global trade in used vehicles, 2017

## 2.1.2 Motorcycles

### *Motorcycle population in Rwanda*

Motorcycles account for up to 46% of the total cumulative vehicle fleet in Rwanda. Rwanda had 98,807 registered motorcycles as of 2017, an increase from 93,866 motorcycles as of 2016. Approximately 95% of motorcycles in Rwanda run on 4-stroke engines and use gasoline<sup>23</sup>.

Table 4 below shows the number of registered motorcycles in Rwanda by time period.

**Table 4: Number of registered motorcycles in Rwanda by time period**

Up to 1999	2000-2005	2006-2011	2012-2017	Total
2,284	13,357	37,905	45,261	98,807

Source: REMA, Inventory of Sources of Air Pollution in Rwanda, 2018

<sup>23</sup> National Institute of Statistics of Rwanda, Statistical Year Book, 2017.

### 2.1.3 Three wheelers/ auto rick Shaws in Rwanda

The most recent data from National Institute of Statistics of Rwanda points to only 73 tricycles in Rwanda<sup>24</sup>. This number is however expected to grow steadily as the use of three wheelers especially in other cities of Rwanda continues to grow.

Table 5 below shows the trend of three wheelers registration in Rwanda.

**Table 5: The trend of tricycles registration in Rwanda**

Up to 1999	2000-2005	2006-2011	2012-2017	Total
0	0	60	13	73

Source: Inventory of Sources of Air Pollution in Rwanda, 2018

## 2.2 Non-Road Mobile Machinery (NRMM)

Non-road mobile machinery (NRMM) can be defined as any mobile machine, item of transportable industrial equipment, or vehicle - with or without bodywork that is not intended for carrying passengers or goods on the road and is installed with a combustion engine that may include an internal spark ignition petrol engine, or a compression ignition diesel engine<sup>25</sup>. This category of machines includes small gardening and hand held equipment such as hedge trimmers and hand-held chainsaws, construction machinery, generators, agricultural and farm machinery, pumps, fork lifts among others as discussed in more detail below.

### 2.2.1 Small gardening and hand held equipment

These are mainly gasoline powered lawn and garden equipment (GLGE ) that are used for landscape maintenance in residential neighborhoods, schools, parks, hotels and other public spaces. The equipment in this category ranges from string trimmers to stump grinders and tractors and run on either 2 stroke or 4 stroke engines. These equipment can emit high levels of localized emissions that include hazardous air pollutants, criteria pollutants, and CO<sub>2</sub>.

The table 6 below shows the various types of GLGE and their respective engine configuration.

**Table 6: Types of GLGE**

Type of Equipment	Engine Configuration
GLME	
Leaf Blowers/Vacuums	2 stroke, 4 stroke
Trimmers/Edgers/Cutters	2 stroke, 4 stroke

<sup>24</sup> Ibid

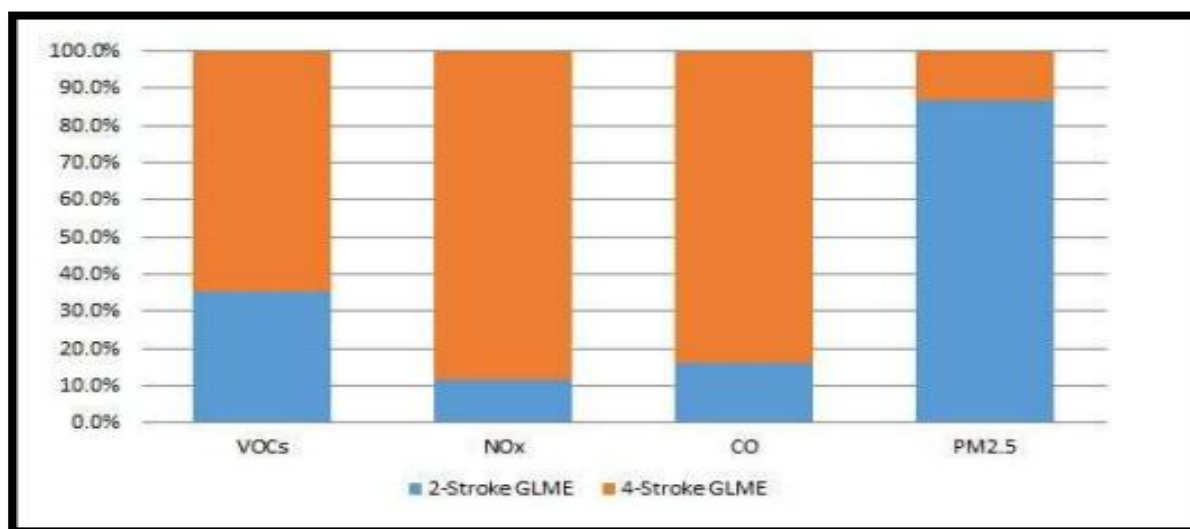
<sup>25</sup> Vehicle Certification Agency, UK, website accessed in May 2018

Mowers	4 stroke
Other GLGE	
Chain Saws	2 stroke, 4 stroke
Rotary Tillers	2 stroke, 4 stroke
Chippers/Stump Grinders	4 stroke
Tractors	4 stroke
Shredders	4 stroke
Turf Equipment	4 stroke

Source: Banks & McConnell, National Emissions from Lawn and Garden Equipment, 2015

Figure 4 below shows emissions from 2-stroke and 4-stroke GLME<sup>26</sup>.

**Figure 4: Comparison of 2 Stroke and 4 Stroke GLME Emissions**



Source: Banks & McConnell, 2015

### 2.2.2 Construction machinery

This category includes machines such as backhoes, compactors, cranes, excavators, Gannon tractors, loaders, motor graders, scrapers and sweepers among others. Emissions from construction machinery occur during construction works such as site preparation, foundation works, road construction and maintenance because they run on fossil fuel. Emissions from these machines include CO<sub>2</sub>, HC and PM thus presents a serious risk to human health and the environment<sup>27</sup>. The pollutants of concern from

<sup>26</sup> Jamie L Banks & Robert McConnell, National Emissions from Lawn and Garden Equipment, 2015.

<sup>27</sup> M. Waris et al., Environmental implications of onsite mechanization in the Malaysian construction industry. Department of Civil Engineering. University Technology PETRONAS, 2014.

the construction sector are dust, NO<sub>x</sub> and particulate matter (PM10 and PM2.5). Much of the emission from this sector, however, is CO<sub>2</sub> and are mostly localized<sup>28</sup>.

### 2.2.3 Agricultural and farm machinery

These are machines used for different farm applications such as land preparations, planting, fertilizer application, pesticides and insecticides application and harvesting among others. Such machines include tractors and combined harvesters among others. These machines are of concern to human health and climate because they are mainly powered on diesel hence contributes significantly to air pollution. Emissions from these machinery cannot be ignored as many countries are embracing agricultural mechanization in a bid to boost their agricultural production.

However, agricultural mechanization in Rwanda is still low since much of the production is done by human labour. As of 2010, 98.5% of all land tillage in the country was by hand held tools, with animal traction and tractors accounting for only 1.4% and 0.1% respectively. The level of agricultural mechanization in Rwanda was envisaged to reach 25% by 2015 and further to 50% by 2020 according to Rwanda Vision 2020<sup>29</sup>.

Table 7 below shows 2010 projections of share of motorized farm equipment in Rwanda by 2015.

**Table 7: Share of motorized farm equipment in Rwanda**

	2010	2011	2012	2013	2014	2015
<b>Power tillers</b>	50	346	991	2973	5550	9910
<b>Tractors</b>	100	217	793	2378	4440	7928

Source: Ministry of Agriculture and Animal Resources, Agricultural Mechanization Strategies for Rwanda, 2010.

### 2.2.4 Generators in Rwanda

Generators in Rwanda are mainly used for powering industries, schools, residential houses, irrigation, hospitals, and commercial buildings among others. They are however mainly used as backups during power outages. It is estimated that about 42% of electricity generation in Rwanda is by diesel generators as a result of shortage of electricity<sup>30</sup>.

<sup>28</sup> H. Fan, A Critical Review and Analysis of Construction equipment emission factors, 2011

<sup>29</sup> Ministry of Agriculture and Animal Resources, Agricultural Mechanization Strategies for Rwanda: Shifting from Subsistence Agriculture to Market-oriented Agriculture, 2010

<sup>30</sup> Rwanda State of Environment and Outlook Report 2015. Chapter VIII, Energy Resources

## 2.3 Emissions from Energy Sector in Rwanda

### 2.3.1 Energy Sector Overview

The Government of Rwanda envisions transitioning from a developing country to a middle-income country. To achieve this goal, the government is targeting 100% electricity access by 2024. Rwanda is endowed with natural resources, including hydro, solar, and methane gas. It currently only has 240 MW of installed generation capacity. Rwanda's national electrification rate has reached 41% (11% off-grid, 30% on-grid). However, over seven million people still lack access to electricity as of 2018<sup>31</sup>.

Table 8 below gives a snap shot of the current share of installed electricity by different source in Rwanda.

**Table 8: Current capacity of installed electricity by source in Rwanda**

Source of supply	Capacity /MW	Contribution /%
Thermal	99.27	41.3
Hydro	102.59	42.69
Methane to power	26.4	10.98
Solar power	12.08	5.03
<b>Total</b>	<b>240.34</b>	<b>100</b>

Source: REMA, Inventory of Sources of Air Pollution in Rwanda, 2018

### **Renewable energy**

Rwanda's renewable energy potential includes: solar, methane, geothermal, peat and wind. Rwanda consumes about 42kWh/year/capita compared with 1,200 kWh for developing countries and 478 kWh in sub-Saharan Africa making it the lowest per capita electricity consumption in the world<sup>32</sup>. Though Rwanda's potential for renewable energy has not been fully exploited, implementing renewable energy projects remains one key strategy for reducing air pollution and GHG emissions from the energy sector.

### **Non- renewable energy**

Non-renewable energy sources in Rwanda includes: thermal fuel energy, peat (under development), and methane gas.

<sup>31</sup> USAID, Rwanda Power Africa Fact Sheet, 2018

<sup>32</sup> Rwanda Energy Sector Review and Action Plan ,2013

Table 9 below gives a snap shot of the number of non-renewable energy plants and their installed capacity.

**Table 9: Installed capacity from non-renewable energy resources in Rwanda**

1. Thermal/diesel power plants			2. Thermal /methane gas power plants	
No.	Plant name	Installed capacity (MW)	Plant name	Installed capacity (MW)
1.	Jabana I	7.8	KPI	5
2.	KESZ TPP	11	Kibuye Gas methane	25
3.	Jabana 2	20.5		
	<b>Total 1</b>	<b>39.3</b>	<b>Total 2</b>	<b>30</b>

Source: Department of Electrical and Electronics Engineering, University of Rwanda, 2017

Table 10 below shows station by station emissions from power generation in Rwanda

**Table 10: Thermal power generation station by station emissions in Rwanda**

Fuel Type	NOX (tonnes per MW)	PM10 (tonnes per MW)	PM2.5 (tonnes per MW)	SOx (tonnes per MW)	CO (tonnes per MW)
Installed capacity	6.16	17.86	0.44	31.06	1.20
Light Fuel Oil	2.79	0.14	0.04	6.64	0.93
Heavy Fuel Oil	4.29	2.14	1.29	24.29	0.30
Methane gas	5.79	0.04	0.04	0.01	1.88
Biomass	0.39	0.76	0.65	0.04	0.44
Peat	17.86	2.47	1.00	156.43	1.89

Source: REMA, Inventory of Sources of Air Pollution in Rwanda, 2018



### **2.3.2 Petroleum based fuels in Rwanda**

The main petroleum based fuels used in Rwanda include diesel, gasoline, kerosene, various industrial & auto lubricants, bitumen, black oil, jet fuel and Liquefied Petroleum Gas (LPG). These fuels are used in vehicles including motor cycles, power plants, industrial boilers, and domestic cooking. It is estimated that Rwanda consumes an average of 205 million litres of fuel annually and this is expected to increase in future as the country looks to boost its current fuel reserve and strengthen its capacity for re-exporting oil and oil products to the neighbouring countries<sup>33</sup>. Fuel quality in Rwanda is generally good. Rwanda, just like the other EAC partner states adopted harmonized regional low sulphur fuel standards of 50 ppm for diesel and 150 ppm for gasoline as their national standards effective January 2015<sup>34</sup>

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<sup>33</sup> Republic of Rwanda, Ministry of Infrastructure website, accessed in May 2018

<sup>34</sup> EAS 158: 2012, Automotive Gasoline (Premium Motor Spirit) Specification and EAS 177: 2012, Automotive Gas Oil (Automotive Diesel) Specification.

## CHAPTER THREE

### 3.0 POLICY AND REGULATORY FRAMEWORK FOR AIR POLLUTION CONTROL IN RWANDA

This chapter provides a quick overview of the policy, legal and institutional landscape for air pollution control in Rwanda and provides a foundational basis for the proposed emission standards for fossil fuel engines.

#### 3.1 POLICIES

##### 3.1.1 Rwanda Environmental Policy<sup>35</sup>

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.<sup>36</sup> The policy recognizes air pollution as an emerging problem, though at the time drafting the policy in 2003 air pollution was blamed mainly on emissions from the few industries in the country.

*Among the strategic actions laid out in the policy are efforts to prevent air and soil pollution by emissions of gases and heavy metals from transport equipment; ensuring compliance with international standards in the emission of greenhouse gases due to utilization of energy; and establishing legislation aimed at monitoring regularly climatic changes and reducing to the strict minimum substances which pollute the atmosphere<sup>37</sup>.*

##### 3.1.2 Rwanda Public Transport Policy and Strategy<sup>38</sup>

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, due regard being given 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 intercity, rural, international and urban public transport system for Rwanda.

Some priority actions for the public transport sector include:

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<sup>35</sup> Republic of Rwanda, Rwanda Ministry of Lands, Resettlement & Environment, 2003

<sup>36</sup> Chapter 4

<sup>37</sup> Chapter 5

<sup>38</sup> Republic of Rwanda, Ministry of Infrastructure, 2012

- i) establishing an urban public transportation system in Kigali City to reduce congestion, pollution and costs;
- ii) developing strategies to manage heavy duty vehicles within Kigali CBD;
- iii) developing non-motorized transport (NMT) infrastructure – pedestrian sidewalks and cycle lanes – in Kigali and other cities.

Development of a new comprehensive national transport policy is planned by MININFRA and will cover public transport, freight, road development, parking development and management, NMT, road traffic management, axle load control and inland water transport.

*Some of the current initiatives within the transport sector that are likely to have a positive impact on the air quality in Rwanda 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. 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 the CBD, especially HDVs.*
- *The City of Kigali is implementing car free zones and car free days within the city.*

### **3.1.3 Rwanda National Energy Policy and Strategy<sup>39</sup>**

The vision of the energy sector as outlined in the 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. For the petroleum sub-sector, one of the policy goals is to enhance environmental protection, health and safety by establishing adequate standards and ensuring that these are adhered to.

For the agriculture demand category, 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.

<sup>39</sup> Republic of Rwanda, Ministry of Infrastructure, 2008

For the transport demand category, 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.

For the industry and services demand category, 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.

### **3.1.4 Rwanda National Industrial Policy<sup>40</sup>**

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.

*The National Industrial Policy pledges to enforce the implementation of Rwanda's environmental laws and policies.*

### **3.1.5 Rwanda Vision 2020<sup>41</sup>**

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 united and competitive both regionally and globally.

Environmental protection and management are among the pillars of Vision 2020. Specifically, it is envisioned that by 2020, Rwanda will be a nation in which 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 strengthening of public institutions responsible for environmental protection and management and recognition of the role of the private sector and civil society in environmental management is central to the achievement of the aspirations of Vision 2020.*

<sup>40</sup> Republic of Rwanda, Ministry of Trade and Industry, 2011

<sup>41</sup> Republic of Rwanda, Ministry of Finance & Economic Planning, 2000

## 3.2 LAWS

### 3.2.1 Constitution of Rwanda<sup>42</sup>

The Constitution of the Republic of Rwanda guarantees every person the right to a clean and healthy environment<sup>43</sup>. 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<sup>44</sup>.

*The Rwandan Constitution lays a very strong foundation for environmental safeguards for various sectors that include air quality management and pollution control.*

### 3.2.2 Organic Law Determining the Modalities of Protection, Conservation and Promotion of Environment in Rwanda<sup>45</sup>

This organic law is intended to determine the modalities of protecting, conserving and promoting the environment in Rwanda as envisaged by the 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.<sup>46</sup>

Just like in the Constitution, the organic law not only guarantees everyone the right to a clean and healthy environment but also imposes a duty on the state to protect, conserve and promote the environment<sup>47</sup>.

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<sup>48</sup>.

The law allows the Minister in charge of environmental affairs to issue orders and regulations regarding any activities that may pollute the atmosphere, including the use of any substances that may pollute the air, deplete the Ozone Layer or cause climatic changes<sup>49</sup>. 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

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<sup>42</sup> Republic of Rwanda (2003 rev.2015), Special Official Gazette of 24/12/2015

<sup>43</sup> Article 22

<sup>44</sup> Article 53

<sup>45</sup> No. 04/2005 of 08/04/2005

<sup>46</sup> Article 1

<sup>47</sup> Article 3

<sup>48</sup> Article 25

<sup>49</sup> Articles 26 & 27

that may from time to time be established for the implementation of the organic law.<sup>50</sup> 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.<sup>51</sup>

*The legal basis for putting in place technical standards and limits for motor vehicle emissions as well as emissions from other types of engine operated machines and equipment is therefore well established under the organic law, albeit in general terms. 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)<sup>52</sup>**

This law outlines the functions, powers and administrative structures for the efficient functioning of 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 Rwanda.

*As per the provisions of this Law, REMA has several functions which include, inter alia, implementing Government environmental policy; advising the Government on policies, strategies and legislation related to the management of the environment; putting in place measures to prevent climate change and cope with its impacts<sup>53</sup>. REMA therefore has a critical advisory as well as implementation role in measures for the protection of air quality in Rwanda.*

### **3.2.4 Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda<sup>54</sup>**

This Law determines modalities for preservation of air quality and prevention of air pollution in Rwanda. The law provides for very specific basis for the establishment of air quality standards<sup>55</sup>. The law requires the national authority in charge of establishing quality standards<sup>56</sup> (i.e. Rwanda Standards Board) to:

- i. prescribe criteria and procedures for measuring air quality and air pollutants;

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<sup>50</sup> Article 80

<sup>51</sup> Articles 81 & 88

<sup>52</sup> No. 63/2013 of 27/08/2013

<sup>53</sup> Chapter II, Article 3.

<sup>54</sup> No. 18/2016 of 18/05/2016

<sup>55</sup> Article 4

<sup>56</sup> Ibid

- ii. establish ambient air quality standards in order to curb the impact of air pollutants;
- iii. establish occupational air quality standards for various sources of air pollution which can cause harm to public health;
- iv. establish quality standards that regulate emissions of air pollutants from different sources contributing to air pollution;
- v. establish specific quality standards that regulate industrial activities with a view to avoid or minimize environmental pollution that may result from such industries;
- vi. determine stack heights of chimneys for air emissions;
- vii. Prescribe any matter in relation with or affecting air emission quality standards.

*This law requires owners of any means of transport which is an emission source to control production and emission of air pollutants. Such means of transport must undergo an inspection for emissions control<sup>57</sup>. 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. In addition, the law requires owners of emission sources including power plants, gas extraction, plants, boilers, generators, and furnaces to comply with the relevant quality standards regulations. An Order of the Minister may determine other sites of specific activities that are considered as sources of air pollution.<sup>58</sup> REMA, RSB, City of Kigali and the Districts are the main institutions entrusted with the implementation of this Law.*

### 3.3 MINISTERIAL ORDERS

#### 3.3.1 Ministerial Order Preventing Activities that Pollute the Atmosphere<sup>59</sup>

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 is to prevent activities that have the potential to pollute the atmosphere<sup>60</sup>. 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<sup>61</sup>.

*The Order makes it mandatory for exhaust fumes of motor vehicles to be included in the annual road worthiness test for vehicles. The Order grants traffic police powers to carry out road worthiness tests on vehicles and if need be ban further use of a smoking vehicle until it has been properly repaired<sup>62</sup>. The Order also prohibits industries from emitting dark smoke from their chimneys into*

<sup>57</sup> Article 9

<sup>58</sup> Article 13

<sup>59</sup> No. 003/16.01 OF 15/07/2010

<sup>60</sup> Article 1

<sup>61</sup> Article 2

<sup>62</sup> Article 4

*the air<sup>63</sup>. In the event of noncompliance of industries with the air pollution standard regulations, the Rwanda Environment Management Authority (REMA) is required to suspend their activities for thirty (30) days. Failure to comply with the air pollution standards within 30 days leads to permanent shut down of the non-compliant activities<sup>64</sup>.*

### **3.3.2 Ministerial Order Determining the Modalities of Environment Conservation in Mining and Quarry Extraction<sup>65</sup>**

This Ministerial Order provides for the modalities of environmental conservation in mining and quarrying activities in Rwanda. Besides the requirement for environmental impact assessment<sup>66</sup> 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<sup>67</sup>

*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<sup>68</sup>.*

## **3.4 REGULATIONS**

### **3.4.1 Prime Minister's Instructions preventing air pollution caused by vehicular emissions<sup>69</sup>**

These Instructions were put in place 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.

The Ministries in charge of Environment, Transport, Finance & Economic Planning, and Internal Security were mandated with the implementation of these Instructions<sup>70</sup>.

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<sup>63</sup> Article 5

<sup>64</sup> Article 6

<sup>65</sup> No. 004/Minifom/2010 of 14/09/2010 (Official Gazette No. 41 bis of 11/10/2010)

<sup>66</sup> Article 3

<sup>67</sup> Articles 7&8

<sup>68</sup> Article 11

<sup>69</sup> No. 005/03 of 27/12/2013



*The Instructions provided for the establishment of permissible motor vehicle emissions limits to be specified in the relevant national standards of Vehicle Roadworthiness Test Code developed by the Rwanda Standards Board<sup>71</sup>. The Instructions require all motor vehicles in Rwanda to undergo emissions inspection 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 for emission standards compliance once a year. Any vehicle that does not meet applicable emissions standards is not authorized to operate in Rwanda<sup>72</sup>. In addition, all vehicles imported in Rwanda are required to be equipped with catalytic converters to reduce emissions<sup>73</sup>. To date the instructions still apply especially with respect to emissions inspection and testing for motor vehicles.*

### **3.5 STANDARDS**

#### **3.5.1 Rwanda Standard – Testing of Motor Vehicles for Roadworthiness<sup>74</sup>**

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. Upon inspection and testing under this standard, an examiner was required to reject a motor vehicle in any of the following circumstances:

- i) 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
- ii) 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
- iii) 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
- iv) 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
- v) the exhaust system is positioned such that it can cause danger to pedestrians.

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<sup>70</sup> Article 12

<sup>71</sup> Article 3

<sup>72</sup> Article 5

<sup>73</sup> Article 6

<sup>74</sup> Rwanda Bureau of Standards (2012), RS 145 -1:2012, First edition 2012-05-04

The standard provides for the test method<sup>75</sup> and instruments<sup>76</sup> to be used in carrying out motor vehicles exhaust emission testing.

The standard outlines emission limits for vehicles and engines<sup>77</sup>. The categories of vehicles for which emission limits are set out include:

- i) Emission standards for diesel fuelled passenger cars and light commercial vehicles<sup>78</sup>;
- ii) Emission standards for gasoline and LPG fuelled passenger cars and light commercial vehicles<sup>79</sup>;
- iii) Emission Standards for Heavy-Duty Engines<sup>80</sup>.

*A reading of the original schedules of this Standard reveals a major shortcoming in that Rwanda adopted European Union vehicle emission standards (Euro Standards) meant for new (off-factory) vehicles but which do not apply to vehicles already on the roads. The Rwanda Standard adopted a range of Euro Standards – from Euro III to Euro VI depending on year of manufacture. Subjecting motor vehicles already on the road in Rwanda to these standards is not possible, neither is the existing testing infrastructure capable of carrying out the tests envisaged by these standards. It is therefore necessary to develop new Rwanda Standards that will apply to new vehicles (off-factory, whether imported or locally assembled), used imported vehicles and separate standards for on-road vehicles (already in use), depending on year of manufacture. The schedules containing the emission limits were deleted for the above reasons.*

### **3.5.2 Rwanda Standard – Emissions to the Air by Cement Factories – Guidelines<sup>81</sup>**

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<sub>x</sub>) and other nitrogen compounds
- iii) Sulphur dioxide (SO<sub>2</sub>) and other sulphur compounds.

<sup>75</sup> Rwanda Bureau of Standards, RS 128:2009 EAS 545:2008 Road vehicles - Measurement methods for exhaust gas emissions during inspection or maintenance.

<sup>76</sup> Rwanda Bureau of Standards, RS 256:2009 EAS 578:2008 Instruments for measuring vehicle exhaust emissions.

<sup>77</sup> Annex A of the Standard

<sup>78</sup> Table 1 of Annex A

<sup>79</sup> Table 2 of Annex A

<sup>80</sup> Table 3 of Annex A

<sup>81</sup> Rwanda Bureau of Standards, RS EAS 750 2010

Whereas cement manufacturing is associated with additional pollutants besides the three listed above (e.g. carbon monoxide (CO), volatile organic compounds (VOC), polychlorinated dibenzodioxins and dibenzofurans (PCDD and PCDF), metals and their compounds, HF & HCl and carbon dioxide (CO<sub>2</sub>), at the moment the EAC standards only prescribe emission limits for the three main pollutants only i.e. dust, NO<sub>x</sub> and SO<sub>2</sub>. However, these limits are prescribed in a separate East African Standard, CD/T/67/2007, and Tolerance limits of emissions discharged to the air by cement factories.

*A reading of the standard reveals that the set limits for SO<sub>2</sub> assume that:*

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

*This means 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<sub>2</sub> emissions.*

### **3.5.3 Rwanda Standard – Tolerance limits of emissions discharged to the air by factories<sup>82</sup>**

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<sub>x</sub> and SO<sub>2</sub>, emissions from factories of all kinds, including cement factories.

*During this rapid 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<sub>2</sub> and NO<sub>x</sub>. 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<sub>2</sub> and NO<sub>x</sub> have been recommended.*

### **3.5.4 Rwanda Standard – Air Quality Specification<sup>83</sup>**

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

<sup>82</sup> Rwanda Bureau of Standards, RS EAS 752 2010

<sup>83</sup>Rwanda Bureau of Standards, RS EAS 751 2010

permissible limits of some common air pollutants, namely sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), particulate matter (PM), oxides of nitrogen (NO<sub>x</sub>), hydrocarbons (HC), and lead (Pb). The standard gives imission limits<sup>84</sup> applicable to the ambient air and emission limits<sup>85</sup> applicable to emission sources.

### **3.5.5 Rwanda Standard – Automotive Gasoline (Premium Motor Spirit) Specification<sup>86</sup>**

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.

### **3.5.6 Rwanda Standard – Automotive Gas Oil (Automotive Diesel) Specification<sup>87</sup>**

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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<sup>84</sup> Imission limit refers to the highest permissible weight concentration of pollutants contained in the air.

<sup>85</sup> Emission limit refers to the highest permissible quantity of pollutants released into the air from a pollution source.

<sup>86</sup> Rwanda Bureau of Standards, RS EAS 158:2012

<sup>87</sup> Rwanda Bureau of Standards, RS EAS 177:2012

## CHAPTER FOUR

### 4.0 CURRENT EMISSION TESTING INFRASTRUCTURE IN RWANDA

#### 4.1 Existing testing infrastructure and capacity

Currently, the testing infrastructure for internal combustion engines in Rwanda is mainly for on-road motor vehicles. 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 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.*

#### 4.2 Testing Equipment and parameters tested

MAHA Maschinenbau Haldenwang GmbH & Co. KG<sup>88</sup> – 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

<sup>88</sup> See MAHA's official website at <http://www.maha.de>

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 Combiter** series. This is a combination of MET 6.1 (gasoline/gas) and MET 6.2 (opacimeter) in a compact housing.



- The MET 6.3 Exhaust Gas Combiter has the capability to measure HC, CO, CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub> (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<sub>x</sub>, turbidity, and PM mass concentration<sup>89</sup>. 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<sup>-1</sup>
  - ✓ Measurement for gasoline engine – target values: CO 5% vol. maximum; HC 600 ppm maximum; CO<sub>2</sub> 10% vol. minimum, O<sub>2</sub> 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<sub>x</sub>, turbidity, and PM mass concentration) if need be, and also to set new target values (lower or higher) as may be required by the proposed national standards.

<sup>89</sup> We obtained print-outs of actual test results at the Kigali inspection centre and were able to view the actual parameters tested.

## CHAPTER FIVE

### 5.0 CONCLUSIONS AND RECOMMENDATIONS

The following are the key conclusions and recommendations emanating from the findings and analyses in chapters 2, 3 and 4 of this report:

- Rwanda's current policy, legal and regulatory framework envisages control of air pollution and has sufficient provisions to anchor the proposed technical standards and permissible limits for motor vehicle emissions as well as emissions from other types of engine operated machines and equipment. More specifically, the Law Governing the Preservation of Air Quality and Prevention of Air Pollution in Rwanda requires the national authority in charge of establishing quality standards (i.e. Rwanda Standards Board) to establish quality standards that regulate emissions of air pollutants from different sources contributing to air pollution.
- There has been a previous attempt to put in place Rwanda national standards for emissions from motor vehicles. These standards were initially part of the Rwanda Standard for Testing of Motor Vehicles for Roadworthiness but were later deleted. A reading of the deleted Standard reveals a major shortcoming in that Rwanda adopted European Union vehicle emission standards (Euro Standards) meant for new (off-factory) vehicles but which do not apply to vehicles already on the roads. The standard adopted a range of Euro Standards – from Euro III to Euro VI depending on year of manufacture. Subjecting motor vehicles already on the road in Rwanda to these standards would not be possible, neither is the existing testing infrastructure capable of carrying out the tests envisaged by these standards. This situation made it impossible to implement the standards hence the deletion. It is therefore necessary to develop new Rwanda Standards that will apply to new vehicles (off-factory, whether imported or locally assembled) and separate standards for on-road vehicles (in-use, including imported used vehicles), depending on year of manufacture.
- Despite existing mandatory periodic emission testing for motor vehicles in Rwanda, there is no legally enforceable national standard in place against which the tests are carried out. Current target values for vehicle emissions in Rwanda are based on the manufacturer's default settings in the test equipment (for diesel engine – target value k- max. 5.00 m<sup>-1</sup>; for gasoline engine – target values: CO 5% vol. maximum; HC 600 ppm). Pass or fail is therefore currently based on the above manufacturer settings. There is an urgent need to put in place a national standard and to re-calibrate the test equipment against the set national standard.
- Despite motor cycles being key contributors to overall transport related air pollution in Rwanda, especially in Kigali City, the current mandatory requirement for motor vehicle emissions testing does not cover motorcycles. In addition, the emission testing equipment in the country are few and may not cope with the large numbers of motor cycles in the country. In order to control the rising air pollution from motor cycles, it is recommended that the proposed new standards should

include emission limits for motor cycles, and that regulations be put in place to require periodic emission testing for motor cycles. There will also be need to expand the emission testing and inspection facilities to provide dedicated lanes for motor cycles in order to cope with their large numbers in Rwanda.

- Rwanda's existing emission testing and inspection equipment for vehicle emissions (MET 6.3 Exhaust Gas Combustion Tester) has the capability to measure HC, CO, CO<sub>2</sub>, O<sub>2</sub>, NO<sub>x</sub> (option), K value, turbidity, and PM mass concentration. Even though the equipment is currently calibrated to measure all the above parameters except NO<sub>x</sub>, turbidity, and PM mass concentration, it is possible to re-calibrate it to also measure the missing parameters if need be, and also to set the equipment to measure against new target values (lower or higher) as may be required by the proposed national standards. Therefore, the new standards will not require investment in new equipment but will only require re-calibration of the existing equipment. There is in place a standing agreement with the equipment manufacturer for annual service and maintenance as well as emergency back-up. The re-calibration can therefore be arranged with the manufacturer.
- Just as was noted during this assessment, the recent REMA report – Inventory of Sources of Air Pollution in Rwanda – also pointed out that the EAC standards which Rwanda adopted for emission limits for thermal power plants have inconsistencies that make them impossible to implement, especially for Rwanda's small capacity power plants. The REMA report has recommended the development of Rwanda specific standards, and in the case of thermal power plants, specific emission limits for different pollutants have been proposed in the report, based on the current World Bank/IFC Emission Guidelines for Thermal Power Plants. This report recommends the adoption of the proposed limits in the REMA report as the new Rwanda standard.
- For non-road mobile machinery (including construction and agricultural machinery), engine run hand held equipment and generators, there are currently no Rwanda standards or emission limits in place. Whereas in a few developed countries e.g. UK there is in place in-use emission limits for some of these equipment, majority of countries only have emission standards for new (off-factory) equipment. This is because of the small numbers of these kinds of equipment and their sparse distribution; hence impact on air quality is generally low and localized. In addition, testing infrastructure for in-use NRMM, engine run hand held equipment and generators does not exist in most countries, just like in Rwanda. It is therefore recommended that Rwanda only develops standards for new (off-factory) equipment that can easily be enforced through a regulation requiring that the equipment be accompanied by a certificate of conformance at the time of import (noting that Rwanda does not manufacture any of these equipment).
- 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.



- In terms of approach for the new standards, it is recommended that where standards already exist e.g. on emissions from factories, instead of re-inventing the wheel by drafting a whole set of documents, it will be more efficient to review the current limits in the schedules, especially the EAC limits, for example for power plants, and replace them with new schedules with Rwanda specific limits. As for motor vehicle emissions, it is also proposed to develop schedules for emission limits that will be added to the current standards for inspection of motor vehicles for road worthiness in line with the Prime Minister's Instructions preventing air pollution caused by vehicular emissions. In the case of non-road mobile machinery e.g. construction equipment and agricultural machinery, as well as generators, it is proposed set up a new set of standards.

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