



Laidlaw Research and Leadership Programme

# **Where do our discarded diesel vehicles go?**

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# 1. Introduction

## 1.1 Background

The diesel vehicle market was dominated by Europe. In just 20 years, diesel's market share in Europe increased so quickly, from 10% in the middle of the 1990s to 55% in 2012. The many advantages of diesel contribute to its enormous appeal in Europe. (Rajé, Tight and Pope, 2018)

The modern diesel engine is a prime example of excellent science and cutting-edge technology. The diesel combustion cycle produces a leaner fuel-air combination than the gasoline combustion cycle, which allows diesel engines to run more effectively. Diesel fuel has a higher energy density than gasoline when compared by volume. Diesel engines emit less CO<sub>2</sub> than gasoline ones from an environmental protection perspective. Since reducing greenhouse gases fit into the established global trend of improving air quality, the tendency of diesel engines to release higher amounts of nitrogen oxides (NO<sub>x</sub>) wasn't a major worry at the time. Diesel presents an opportunity for automakers to create effective, low-carbon emission vehicles that adhere to the pollution requirement. The EU governments regulated diesel fuel prices to maintain them below gasoline prices and taxed the registration of diesel-powered passenger cars at a significantly lower rate to complete the significant inducement toward diesel. All of this directly contributed to the increase in diesel car sales in Europe, until the Volkswagen emission crisis in 2015 (Resnick, 2015).

The German carmaker Volkswagen Group receives a notice of violation of the Clean Air Act from the US Environmental Protection Agency (EPA) in September 2015, casting doubt on all diesel output. Volkswagen was revealed to have lied about its emissions during laboratory testing in order to have the vehicles' NO<sub>x</sub> output satisfy US requirements. In actual driving, the vehicles released up to 40 times more NO<sub>x</sub>. Early in the 2000s, NO<sub>x</sub> emissions attracted little attention, but soon specialists discovered that NO<sub>x</sub> has a number of health impacts: As a precursor to ground-level ozone and a contributor to acid rain, NO<sub>x</sub> can aggravate respiratory conditions such as asthma, bronchitis, and emphysema. According to a peer-reviewed study, the additional pollution created between 2008 and 2015 by vehicles with the defeat device in the United States will result in about 59 premature deaths, most of which will be caused by particle pollution (87%) and the remaining by ozone (13%) (Vaughan, 2015). According to the European Environment Agency, 68000 premature deaths in Europe occurred in 2013 alone as a result of NO<sub>2</sub> exposure.

The Volkswagen crisis was just the beginning. Nearly all automakers, according to Transport & Environment, go over the NO<sub>x</sub> restrictions for Euro 6 by at least two times. Regulations governing NO<sub>x</sub> emissions for automakers were quickly established in Europe. To minimise emissions, millions of vehicles must be upgraded with particulate filters and software updates; those that were too old or unworthy of an update will be scrapped or exported to other nations.

Africa makes up 40% of the world's used car market, and at least 85% of the continent's fleet is made up of old cars. (United Nations Environment Programme, 2020)

Between 1990 and 2013, vehicle emissions were blamed for almost 250 000 deaths in Africa, but more than half of the continent's nations have no import limits on used cars. Clean automobiles are urgently needed. There isn't a clear picture of used diesel vehicles in Africa up until now due to the dearth of vehicle management and environmental data

in the continent. Using statistics from European and US customs export data, this analysis calculates the import of used diesel automobiles into Africa and forecasts the resulting environmental effects.

## **1.2 Objective**

The objective of this project is to use online resources to track the destiny of abandoned diesel automobiles from the United Kingdom, the United States, and the European Union and evaluate how they affect air quality, climate change, and human health in African nations.

The study's scope includes three specific components of the trade flow for used diesel cars:

1. The principal exporting and importing nations
2. Rules for importing used cars in each African nation
3. Calculated exhaust emissions from secondhand diesel cars imported from abroad

This study will elaborate on each of these areas in depth, discuss the results of the data analysis, and offer suggestions as well as additional research implications.

## **2. Methodology**

This study extrapolates annual trade data from EUROSTAT (Comext) and USA Trade to estimate the import of used diesel vehicles into Africa for the period of 2017–2021. The range of vehicle types includes passenger cars that transport people, road tractors with semi-trailers, and motor vehicles that transport commodities. The Harmonized Commodity Description and Coding System (HS Code) is used by the USA Trade and Eurostat databases to track the global trade fleet.

Table 1 displays the precise HS Code headings for the used diesel cars analysed for the study. All countries use the same first six digits, which are divided into Chapter (first two digits), headings (first four digits), and subheadings (full 6 digits) (findrulesoforigin.org, n.d.). Depending on the country, the HS code is further broken into numerous digits. In this case, the first 2 digits 87 refer to Chapter 87 "vehicles other than railway or tramway rolling stock, including parts and accessories thereto"; 3-4 digits (01-04) separate vehicles into different types depending on usage, 5-6 digits divide vehicles depending on propulsion type (we extracted only the data categories using diesel/diesel-electric) and last few digits identify properties including weight, cylinder capacity, new/used.

Classification	Propulsion type	Europe	USA
road tractors for semi-trailers	compression-ignition internal combustion piston engine	87 01 21 90	8701.21.0080
	compression-ignition internal combustion piston and electric motor	87 01 22 90	8701.22.0080
motor vehicles, transport of persons ≥10	compression-ignition internal combustion piston engine	87 02 10 19 87 02 10 99	NA
motor vehicles, transport of persons <10	only compression-ignition internal combustion piston engine	87 03 31 90 87 03 32 90 87 03 33 90	8703.32.0150 8703.32.0050 8703.33.0185 8703.33.0085
	compression-ignition internal combustion piston and electric motor	NA	8703.70.0050 8703.70.0090 8703.50.0050 8703.50.0090
motor vehicles, transport of goods	only compression-ignition internal combustion piston engine	87 04 21 39 87 04 21 99 87 04 22 39 87 04 23 39	NA
	compression-ignition internal combustion piston and electric motor	87 04 41 39 87 04 41 99 87 04 42 99 87 04 43 99	NA

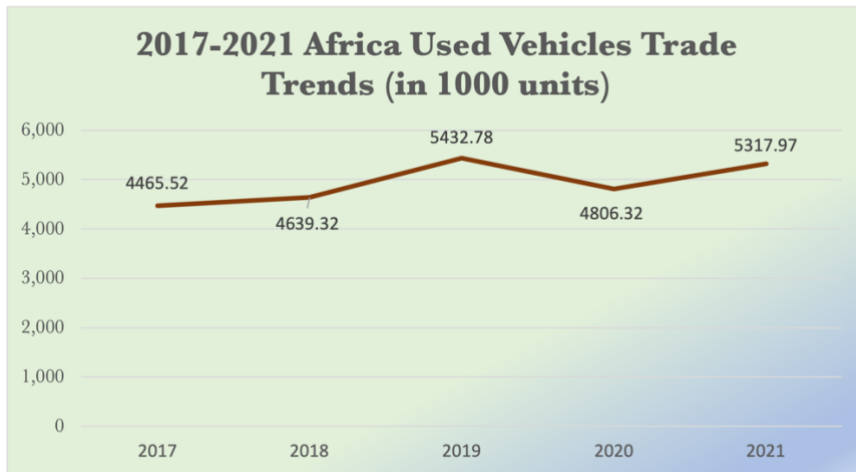
(Table 1: HS subheadings related to used diesel vehicles)

There are a few issues that can occur when data is extracted from the database using the HS code:

1. Because HS codes fluctuate from nation to nation, there will inevitably be inaccuracies in calculations for various vehicle kinds.
2. Because different databases use different definitions of the same unit, there are significant differences in the numbers for the same subject across databases. Here, our analysis is based primarily on data quantifying methods from USA Trade and Eurostat.
3. Each entry solely lists the export and import countries without considering the potential for re-export to nearby nations. For instance, South Africa forbids the import of used vehicles, but the country nonetheless imports a sizable number of used vehicles each year.

### 3. Used diesel vehicles market

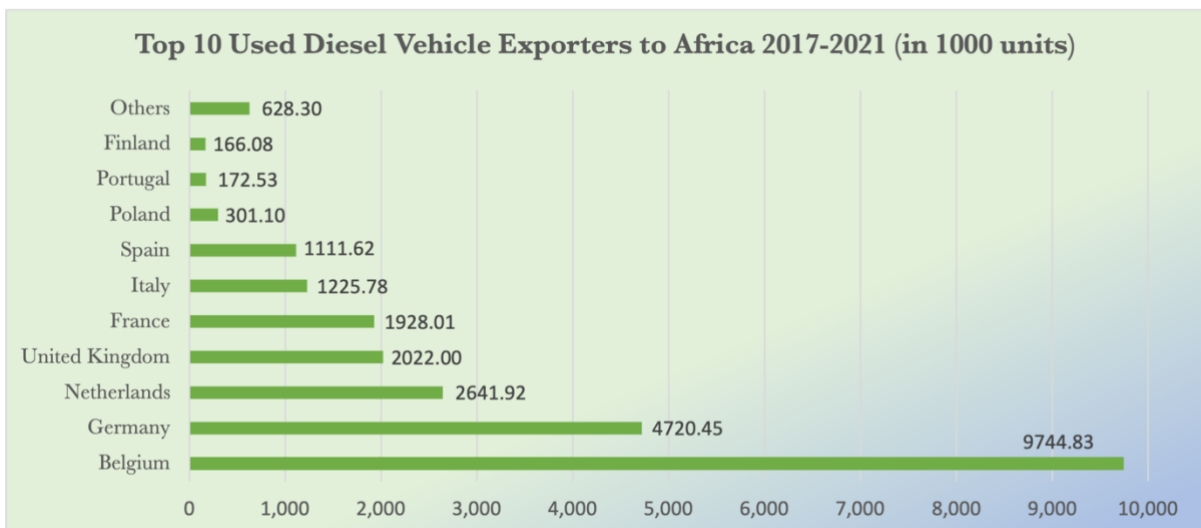
The entire trade flow of discarded diesel vehicles from Europe and the US to Africa has been growing steadily over the past five years, with a little decline in 2020, primarily because of the influence of the Covid-19 outbreak on the world trading system (see Figure 1). The number rises to 5.3 million in 2021, and this figure includes registered individuals, a sizeable fraction of whom are not yet counted for various reasons. As a result, used diesel cars from Europe and the US are a major source of transportation in Africa. It is necessary and crucial to comprehend the used diesel car market in Africa and adapt to relevant legislation and controls given the size of the sector.



(Figure 1. Africa Used Vehicles Trade Trend from 2017 to 2021)

### 3.1 Top 10 exporters and importers of used diesel vehicles

Figure 2 lists the top 10 EU, UK, and US exporters of used diesel automobiles to Africa. With a share of 28.11%, Belgium tops the list of exporters, followed by Germany with a share of 13.62%. The newly enacted limits on pollution standards were particularly detrimental to both countries' major automakers in Europe. Only 2.7 million of Germany's 15 million diesel automobiles have Euro-6 technology as of 2018, and this is just a sample of the full commercial fleet. The remaining 10 million diesel autos must comply with the law and be disposed of (German court to rule on city bans for diesel cars, 2018).

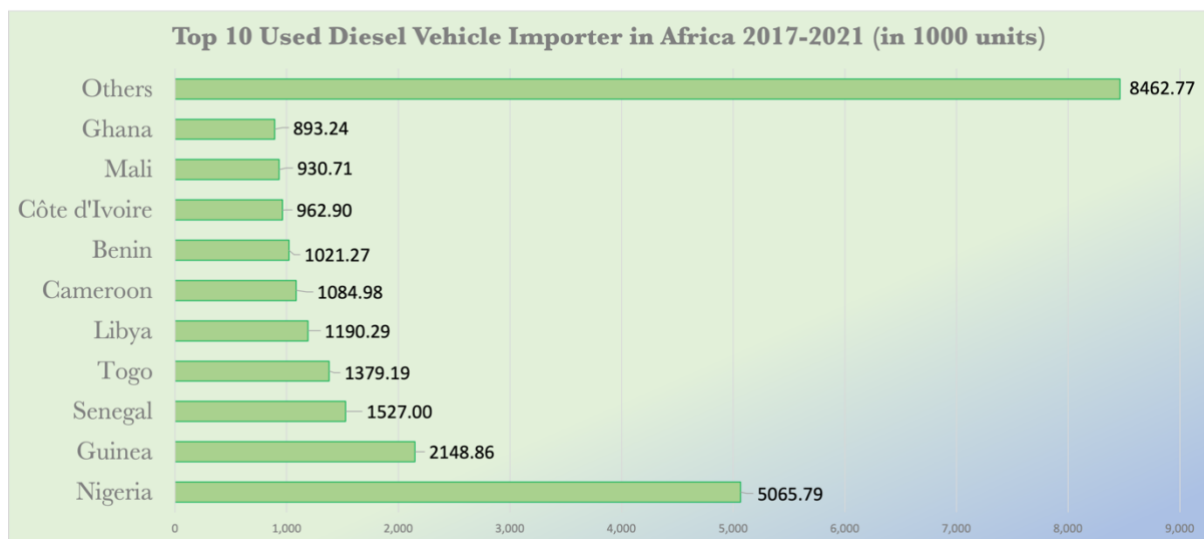


(Figure 2: Top 10 Used Diesel Vehicle Exporters to Africa from 2017 to 2021)

The US does not appear in any of the Top statistics, even though it is one of the 3 major used vehicle exporters in the world. This is probably due to the following causes:

1. There are only 5% of diesel vehicles available in the US, and unlike Europe, where taxes on diesel vehicles have previously been greatly cut, the high levies in the US have discouraged many consumers from buying diesel vehicles.
2. The Middle East and Central America are the top exporting regions to the US.

3. HS code in the USA Trade system includes fewer codes connected to used diesel vehicles. And as aforementioned, different calculation methods in systems might result in very different results.



(Figure 3: Top 10 Used Diesel Vehicles Importers in Africa from 2017 to 2021)

The top 10 importers of secondhand diesel automobiles into Africa are shown in Figure 3. Nigeria with a 20% share ranked top of the list, followed by Guinea, Senegal, Togo, Libya, Cameroon, Benin, Côte d'Ivoire, Mali, and Ghana. Nigeria's vast population and low national GDP are factors contributing to the country's high imports. As shown in Table 2, the strong demand in most countries is due to the difficulty in producing automobiles domestically and the inability to pay for new imports. Only Libya is an upper-middle income country among the top 10 imports; the others are either low-middle income or low income. Even though many experts have advocated for a complete ban on used car imports due to environmental concerns, these imports substantially meet the demand for automobiles in various African nations. Therefore, rather than outright banning imported cars, the focus should be on raising their quality.

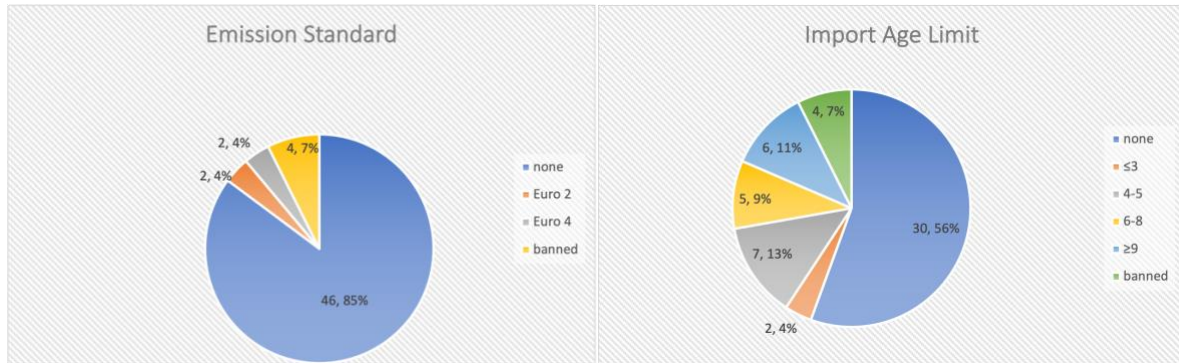
County	GNI Status	% of region imports
Nigeria	Low-middle income	20.54%
Guinea	Low-income	8.71%
Senegal	Low-middle income	6.19%
Togo	Low-income	5.59%
Libya	Upper-middle income	4.83%
Cameroon	Low-middle income	4.40%
Benin	Low-middle income	4.14%
Côte d'Ivoi	Low-middle income	3.90%
Mali	Low-income	3.77%
Ghana	Low-middle income	3.62%

(Table 2: Top 10 importers in Africa with GNI status)

### 3.2 Import regulations in African countries

Import restrictions can take many different forms, such as taxes, border checks, environmental standards, and import age restrictions. African nations are now putting

import vehicle rules into various levels of implementation. Subregions take seriously the necessity for African nations to develop and execute automotive laws. At regional levels, some people came to agreements. All 15 members of the Economic Community of West African States (ECOWAS) tentatively agreed to a set of rules in February 2020 to encourage the use of cleaner fuels and automobiles throughout the region (Ayeter et al., 2021). This analysis excludes agreements made at the regional level and instead focuses mostly on national laws governing age restrictions and emission requirements.



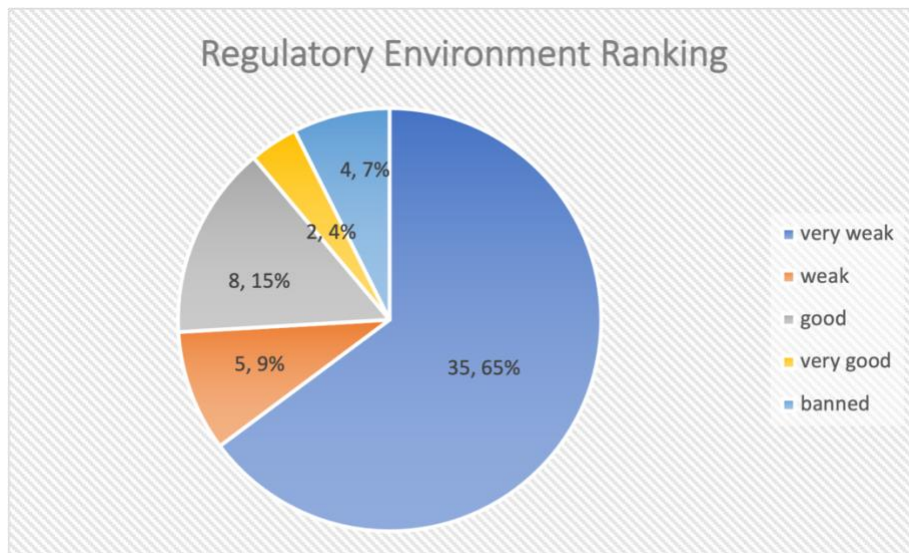
(Figure 4: Emission standard and Age limit statistics of African countries)

Of the 54 African countries investigated, 4 countries (Egypt, Seychelles, South Africa, Sudan) ban used vehicles import. Only two of the remaining 50 nations (Nigeria and Ghana) have the Euro 2 standard, and two (Rwanda and Morocco) have the Euro 4 standard, while the remaining 46 nations have no emission standards at all. The situation with age restrictions is also similar; only two nations have age restrictions of less than three years, seven have limits of 4-5 years, eleven have limits of more than six years, and 30 nations have no age restrictions at all. (see Figure 4)

UNEP Regulatory Environment Ranking	
Very Good	a used vehicle Euro 5 or more emissions standard adopted and/or age limit of 3 years or below
Good	a used vehicle Euro 4 emissions standard adopted and/or age limit of 4 or 5 years
Weak	a used vehicle Euro 3 emissions standard adopted and/or age limit of between 6-8
Very Weak	No used vehicle Euro emissions standard adopted and/or age limit of 9 years plus or no age limit

(Table 3. UNEP Regulatory Environment Ranking)

Based on UNEP's Regulatory Environment Ranking (see Table 3), less than 20% of African countries are classified as Good or Very Good in ranking while 65% of countries are classified as Very Weak, the majority of which have no regulations at all. As a result, Africa urgently needs to impose import regulations. (see Figure 5)



(Figure 5. African Countries Regulatory Environment Ranking based on UNEP standards)

### 3.3 Estimated Exhaust Emissions

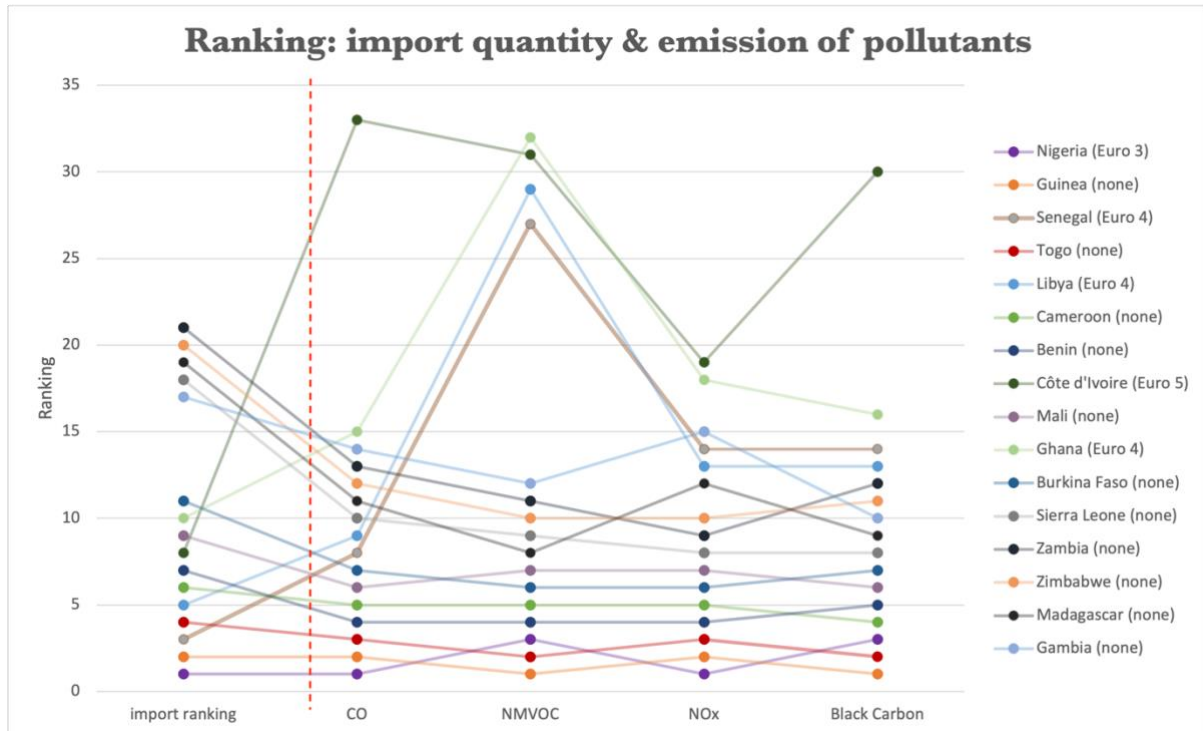
The European Environment Agency's 2019 EMEP/EEA air pollutant emission inventory handbook is used in this study to simulate emission contaminants. The Tier 2 method considers the types of gasoline that various vehicle categories consume as well as their emission requirements. To obtain the result, the user must supply the total number of vehicles and the annual mileage for each technology (or the number of vehicle km for each technology). However, due to a lack of this information, this study only displays the emission status at the first level of computation.

		CO <sub>2</sub>	NM <sub>2</sub> VOC	NO <sub>x</sub>	NH <sub>3</sub>	PM <sub>2.5</sub>	Black Carbon
diesel light commercial vehicles	no regulation	1.34	0.133	1.66	0.0012	0.356	0.1958
	Euro 2	0.577	0.149	1.22	0.0012	0.117	0.06435
	Euro 4	0.375	0.035	0.831	0.0012	0.0409	0.022495
diesel medium passenger cars	no regulation	0.688	0.159	0.546	0.0010	0.2209	0.125913
	Euro 2	0.296	0.035	0.716	0.0010	0.0548	0.031236
	Euro 4	0.092	0.014	0.58	0.0010	0.0314	0.017898
diesel large passenger cars	no regulation	0.688	0.159	0.87	0.0010	0.2209	0.125913
	Euro 2	0.296	0.10	0.716	0.0010	0.0842	0.047994
	Euro 4	0.092	0.014	0.58	0.0010	0.0548	0.031236
diesel ≤7.5t heavy-duty vehicles	no regulation	1.85	1.07	4.7	0.0029	0.333	0.17649
	Euro 2	0.537	0.123	3.49	0.0029	0.061	0.03233
	Euro 4	0.047	0.005	1.64	0.0029	0.0106	0.005618
diesel 7.5t-16t heavy-duty vehicles	no regulation	2.13	0.776	8.92	0.0029	0.3344	0.177232
	Euro 2	0.902	0.207	5.50	0.0029	0.104	0.05512
	Euro 4	0.071	0.008	2.65	0.0029	0.0161	0.008533
diesel ≥16t heavy-duty vehicles	no regulation	2.09	0.51	11.75	0.0029	0.4545	0.240885
	Euro 2	1.62	0.308	8.635	0.0029	0.1745	0.092485
	Euro 4	0.113	0.011	4.22	0.0029	0.02535	0.0134355

(Table 4. Emission Factors from European Environment Agency)

Table 4 lists the emission factors. Vehicles in Tier 2 are divided into three major categories: light commercial vehicles (LCV), heavy-duty vehicles (HDV), and passenger cars. Based on weight and size, the three categories are further divided. Emission factor, meanwhile, is connected to Euro standards. The table illustrates the relationship between value decline and rising emission standards. This study assesses and

categorises the various vehicle types according to their emissions. We also use import year - age limit = actual year to compare the actual year with the Euro Standard at that year because the environmental data did not account for the impact of age restrictions and more African countries impose age limit restraints than mission standards. Thus, the following environmental statistics are obtained:



(Figure 6. Changes in country ranking by emission pollutants)

The Top 10 countries (stated in Figure 3) and other nations that placed in the Top 10 in subsequent rankings are included in this analysis. The starting point is their import quantities ranking. Here, we use the following pollutants as indicators of the severity of environmental harm caused by used vehicles: carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), nitrogen oxides (NOx), and black carbon. The column series corresponds to their environmental emissions ranking, with 1 denoting the highest amount of pollution. The following observations have been made:

1. Due to their outstanding regulation, certain nations (Senegal, Euro 4, Libya, Euro 4, Côte d'Ivoire, Euro 5, Ghana, Euro 4) rated much lower in terms of environmental pollution than their import quantity rating.
2. For the nations included in this statistic but not initially placed among the top 10, all of them are shown as "None" in regulation data. Thus, lack of control is a significant factor in their high rankings for pollution emissions.
3. Nigeria imports more than twice as much as the second-place country, but because to its 15-year age limit and Euro 2 emission criteria, it can only be ranked third in terms of NMVOC and Black Carbon.

The data presented above demonstrate the crucial connection between regulations and environmental pollution. Since many African nations are unaware of the damaging

effects of abandoned automobiles on the environment, it is necessary to establish import guidelines. Importing high-quality used cars can significantly reduce this impact.

## **4. Conclusions**

### **4.1 Recommendations**

By examining the general commerce fleet of discarded diesel vehicles in African nations, the study aims to comprehend the unintended repercussions of air quality policy initiatives. The annual volume of used diesel car imports into Africa has been examined using international annual trade statistics from 2017 to 2021 and further implications are analysed.

Recommendations drawn out of this research include the following:

1. Establish an international vehicle standard. Currently, Africa finds it challenging to adopt a uniform strategy due to differences in the enforcement and testing of vehicle standards around the world, which has led to a stalling of regulation in different African countries at different phases.
2. African nations should concentrate on refining or adopting import laws to improve the quality of imported used diesel automobiles rather than outright banning used cars. Measures include age limitations, Emission pollutant requirements, implementation of fiscal instruments (tariff based on engine technology, size, etc.) and introduction of hybrid electric vehicles.
3. Introducing new, eco-friendly fuel that is compatible with imported cars. The technology of imported secondhand cars is often more advanced than that of locally produced vehicles in several African nations. To be effective, high-tech engines must be paired with the right clean diesel, yet many African nations continue to utilise low-quality fuel for vehicles with Euro 4 and higher emissions standards, which prohibits emissions from meeting the Euro 4 requirement.
4. Offering hybrid vehicles as an option. The analysis accounts for both diesel and diesel-electric vehicles, however, the proportion of diesel-electric vehicles is minuscule. The issue of secondhand diesel vehicles in Africa would be greatly alleviated if situations in African nations permitted the usage of such vehicles on the road.

### **4.2 Suggestions for future research**

This study fell short of meeting all of the objectives. Through data on vehicle numbers, usage patterns, and environmental conditions, the study aimed to more clearly illustrate the effects of discarded diesel vehicles on African people's lives and health. This article only presents macro estimates in terms of environmental analysis due to the dearth of online resources. However, if the following information had been accessible, the study might have progressed further:

1. The annual amount of fuel used for road transportation in African countries. This information aids in the more precise estimation of yearly diesel vehicle usage in

African nations, which is then used to determine various environmental pollution estimates for used diesel vehicles.

2. The total number of automobiles on the road in African nations each year and their annual mileage. This information can be used to estimate the annual environmental pollution that used diesel cars in African nations cause.
3. Each imported vehicle's mileage. It gives a visual picture of the amount of pollution that a used diesel vehicle that enters Africa must produce there over the course of its lifetime.
4. Imported car emission goals. The earlier estimations were based on the national legislation of each country, but if an international database could include this information with the registration data, it would make the computations more accurate.

The information above focuses on more precise diesel fuel usage and vehicle mileage. They contribute to the connection between imported diesel vehicles and their final emissions, providing a more accurate understanding of the connection between health and safety and abandoned diesel vehicles.

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