

Controlling Air Pollution: The Case of Imported Second-Hand Cars in Addis Ababa

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Advisor:
Assistant Professor Mekete Belete

Elsabeth Belay

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Acronyms

AAEPA	Addis Ababa Environmental Protection Authority
AAU	Addis Ababa University
CFC	Chlorofluorocarbon
CO	Carbon Monoxide
ECA	Ethiopian Customs Authority
EEJA	Ethiopian Environmental Journalists Association
EPA	Environmental Protection Authority
EPE	Ethiopian Petroleum Enterprise
ETA	Ethiopian transport Authority
FDRE	Federal Democratic Republic of Ethiopia
FfE	Forum for Environment
GHG	Greenhouse Gases
MoME	Ministry of Mine and Energy
NGO	Non-Government Organization
NO	Nitrogen Peroxide
NO _x	Nitrous oxides
Pb	Lead
PM	Particulate Matter
UNEP	United Nations Environmental Programme
UNHABITAT	United Nations Habitat Programme
VOC	Volatile Organic Compound
WB	World Bank
WHO	World Health Organization

Introduction

Air pollution is caused mainly due to vehicular emissions, and major pollutants emitted from motor vehicles. Nowadays, Addis Ababa's ambient air quality is experiencing degradation as a result of emissions contributed particularly from old vehicles. This paper will try to explain the general terms and characteristics of air pollution and specifically motor vehicle emissions. The paper then discusses the Ethiopian legal instruments concerning air pollution, especially for mobile sources of air pollution, and some implementation practices in other countries in regard to regulating vehicular emissions.

Finally, the paper examines the practicability of the legal instruments by their respective actors and challenges encountered during implementation, and also suggests possible recommendations in view of systematic regulatory solutions, integration between responsible actors, and direction of implementation. Nowadays air pollution over major cities throughout the world has become overburdened with gases produced by automobiles. With passage of time people realized that polluted air had serious effects on their health, climate and economics. Weather and climate have the integrated impact on human activities which are resulting in worldwide concentration of the particulate of environmental pollution with chlorofluorocarbons (CFCs), carbon dioxide, methane, nitrogen oxide, lead and several other dust and gaseous particles. The fast growing use of motor vehicles in rapidly industrializing low-income countries like Ethiopia is contributing to high levels of urban air pollution, in addition to other adverse socioeconomic impacts.



Controlling Air Pollution: The Case of Imported Second-Hand Cars in Addis Ababa

BY 2050,

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Two-thirds of the developing world's population is likely to live in urban areas.

1. CHAPTER ONE – AIR POLLUTION

1.1. General Overview

Air pollution is either due to gases (in the source of carbon monoxide, nitrogen dioxide, sulfur dioxide, benzene and ozone) or particulates (forming dust, smoke, mist, vapor and fume). Air pollution is popular for its contribution for climate change nowadays. It also worsens the living situation of mankind – affecting their health, causing damage to their habitat and creating burden on mitigation activities. Developing countries are the most affected part of the world to this irreversible (most of the time) phenomenon. The most common ambient air pollutants in urban areas include stationary, mobile sources and domestic fuel sources.

Transport is the main cause for the increasing air pollution. The growing use of old, poorly maintained cars and the use of diesel fuel have intensely worsened air quality. The transport source is a major contributor for many pollutants, such as sulfur, carbon monoxide and other fine particulate matters.¹

In order to design effective approaches to pollution management from mobile sources, it is important to monitor vehicular emissions, determine their impact, and identify affordable and sustainable solutions.

1.2. Definitions of Air Pollution

Air pollution is the introduction into the air of any substance different from any of its natural constituents. It is therefore a man-made problem from four main sources, namely, industrialization, tobacco smoking, domestic cooking and vehicular or machinery fuel combustion.²

The Black's Law dictionary defines the term *air pollution* as follows:

*"Any harmful substance or energy emitted directly or indirectly into the air, especially if the harm is to the environment or to the public health or welfare"*³

In addition, air pollution is defined by WHO as:

*"The presence in the air of substances put there by acts of man in concentrations sufficient to interfere with the comfort, of safety or health of man or with the full use or enjoyment of his property."*⁴

The two definitions address air pollution differently. The later explains that air pollution is being caused by manmade emissions whereas the former explains it in general terms. In both definitions, air pollution affects humans and their environment.

1.3. Sources of Air Pollution

Nowadays, following the rapid industrialization of nations worldwide, cities' growth can be characterized by increased population and economic development. Inhabitants of these cities demand higher levels of energy as their lifestyle advances towards civilization. Increasing traffic, establishment of manufacturing plants and domestic activities consume significant amounts of energy every day. Increasing activities in these social and economic sectors at personal, national, and global levels are contributing considerably to air pollution by releasing substantial amount of indoor and outdoor air pollutants into the atmosphere.

Unmanageable forms of consumption and production of energy resources by manufacturing, transportation and household sectors have been the major aggravating factors for the emission of major air pollutants. Sources of air pollutants are categorized as mobile or stationary and are favored by natural or anthropogenic occurrences⁵. Some scholars further categorize sources of air pollution as direct or indirect. However, this paper considers mainly the direct ones.

Mobile sources: these are sources emitting pollutants as they move from place to place. These sources exist in the mode of road, rail, marine and air transport. The nature in mobility of the motor vehicles is a major factor making it difficult to regulate their operation so as to reduce the amount and

composition of emissions. Details with regard to vehicular emission will be dealt with later in the next sessions.

Stationary sources: examples include manufacturing factories and power plants. These sources are relatively easier to manage and regulatory standards can be set accordingly⁶.

Domestic sources: household fuel burning and tobacco smoking are worth mentioning in terms of degrading air quality. Cooking is done mostly, especially in developing countries, using firewood, coal and kerosene. Substantial amounts of pollutants are produced and emitted into the air from chimneys, cigarettes and coal stoves.⁷

1.4. The impact of air pollution

1.4.1. Human health impacts

Among other adverse socioeconomic, environmental, and welfare impacts, the notable impacts of air pollution are on human health; which include loss of life, chronic respiratory illness, cardiovascular defects, and carcinogen. Urban residents, in particular, are extremely exposed to contaminated air especially with pollutants released from industry, transportation and household activities such as cooking and tobacco smoking.

Exposure to emissions of lead, mercury, sulfur dioxide, particulate matter, carbon dioxide, and ozone-forming nitrogen dioxides are hazardous to public health. Toxic compounds, like mercury and lead, poison organ systems and can lead to brain damage and death. Ozone and particulate matter can cause respiratory and other health problems, particularly in young children, pregnant women, the elderly, and people suffering from heart and lung diseases.⁸

One of the well-known impacts of air pollution is an increase in asthma attacks. Asthma is the most common chronic disease of childhood with around one in seven children affected. The severity in the type of pollution, the level (pollutant concentration) and duration of exposure and the personal susceptibility of an individual affect people exposed to pollution.⁹

1.4.2. Environmental Impact

Any hazardous air pollutants can cause adverse environmental impact. Environment is degraded as a result of natural or anthropogenic emission of chemical substances and particulates which have the potential to disrupt the normal existence of natural resources. The emission of these pollutants results in acidification, lead intake, ozone formation, respiratory infection and radioactive forcing of climate change. Air pollution, among other pollution types, is the forerunner in imposing

irreversible environmental degradation. Ground-level ozone: damages vegetation; Acid rain: reduces soil fertility and water quality.¹⁰

Main pollutants causing negative environmental effect include: climate change pollution (CO₂); ozone-causing pollution (NO_x); acid rain causing pollution (SO₂); particulate matter pollution (PM); toxic lead pollution (Pb); and toxic mercury pollution (Hg). These pollutions cause damage to:¹¹

- Vegetation and animals
- Buildings and materials
- Ecosystems

1.4.3. *Economic Impacts*

Economic impact of air pollution can be characterized by the deterioration of human health and loss of life bundled with environmental degradation. The costs of health care, days of work lost, premature deaths and other related economic depletions are of noteworthy amount. Decrease in annual agricultural production caused by degraded fertility of soil, climate change, acidity of the waters and deformation of the ecosystems results in higher economic loss. When productive citizens and natural resources are adversely affected by the impact of air pollution, particularly in most developing countries where the national economy relies mainly on agricultural production, the overall economy declines remarkably.¹²

Table 1 - Sources and Effects of Common Air Pollutants¹³

Pollutant	Anthropogenic Sources	Health Effects	Environmental Effects
Ozone (O₃)	Secondary pollutant formed by chemical reaction of VOCs and NO _x in the presence of sunlight.	Breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduces resistance to colds and infections, premature aging of lung tissue.	Damages crops, forests, and other vegetation; damages rubber, fabric, and other materials; smog reduces visibility.
Nitrogen Oxides (NO_x)	Burning of gasoline, natural gas, coal, oil. (Cars are a major source of NO _x .)	Lung damage, respiratory illnesses, ozone (smog) effects.	Ozone (smog) effects; precursor of acid rain which damages trees, lakes, and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate.
Carbon Monoxide (CO)	Burning of gasoline, natural gas, coal, oil.	Reduces ability of blood to bring oxygen to body cells and tissues.	
Volatile Organic Compounds (VOCs)	Fuel combustion, solvents, paint. (Cars are a major source of VOCs.)	Ozone (smog) effects, cancer, and other serious health problems.	Ozone (smog) effects, vegetation damage.
Particulate Matter	Emitted as particles or formed through chemical reactions; burning of wood, diesel, and other fuels; industrial processes; agriculture (plowing, field burning); unpaved roads.	Eye, nose, and throat irritation; lung damage; bronchitis; cancer; early death.	Source of haze which reduces visibility. Ashes, smoke, soot, and dust can dirty and discolor structures and property, including clothes and furniture.
Sulfur Dioxide (SO₂)	Burning of coal and oil, especially high-sulfur coal; industrial processes (paper manufacturing, metal smelting).	Respiratory illness, breathing problems, may cause permanent damage to lungs.	Precursor of acid rain, which can damage trees, lakes, and soil; aerosols can reduce visibility. Acid rain also causes buildings, statues, and monuments to deteriorate
Lead	Fuels and leaded gasoline; paint; smelters (metal refineries); battery manufacturing.	Brain and nervous system damage (esp. Children), digestive and other problems. Some lead-containing chemicals cause cancer in animals.	Harm to wildlife and livestock.
Mercury	Fossil fuel combustion, waste disposal, industrial processes (incineration, smelting, chlor-alkali plants), mining.	Liver, kidney, and brain damage; neurological and developmental damage.	Accumulates in food chain.

1.5. Vehicular Emission

The increasing growth in usage of motor vehicles as transportation means in rapidly industrializing low-income nations is contributing to high levels of urban air pollution. Due to sharp increasing trend in number of vehicles, automobile pollution has put governments in a great concern. Tons of reactive atmospheric gases are emitted from motor vehicles as a result of combustion of gasoline and diesel fuels. The worst thing about vehicular pollution is that it cannot be avoided as the vehicular emissions are emitted at the near-ground level where we breathe. Pollution from vehicles gets revealed through symptoms like cough, headache, nausea, irritation of eyes, various bronchial and visibility problems and are due to discharges like CO, unburned HC, Pb compounds, NO_x, soot and aldehydes, among others, from the tailpipes of vehicles.

The rapidly growing number of second-hand cars coupled with insufficient road networks and usage of low quality fuel aggravate the severity of air pollution. Distance travelled, age and maintenance level of the vehicle, type and quality of fuel used determine concentration level and composition of pollutants released to the air. Other factors include poor driving skills, perception of the general public in terms of choice of a specific transport mode, cold starts, vehicle mass, price differential between diesel and petrol fuels, government policies related to transport and economic situation of the public.¹⁴

1.5.1. Types of Vehicular Emissions

There are two major categories of vehicular emissions: exhaust (tailpipe) emissions and evaporative (vapor) emissions.

a. Exhaust Emission

Also called tailpipe emission, this form of vehicular emission can be subdivided into start-up emissions (categorized as cold-start or hot-start based on how long the vehicle has been turned off) and running emissions, which occurs when the vehicle is warmed up and operated in a hot stabilized condition. Major exhaust pollutants include hydrocarbons (HC), nitrogen oxides (NO_x), carbon monoxide (CO) and carbon dioxide (CO₂).

b. Evaporative Emission

Vapor emissions consist entirely of volatile organic compounds (VOCs). Three forms of vapor emissions namely: **running losses** (occur when the vehicle is operating in a hot-stabilized condition); **hot soak emissions** (results from fuel evaporation from the still-hot engine at the end of the trip); **diurnal emissions** (results from evaporation of fuel from the gasoline tank whether the vehicle is driven or not); and **refueling emissions** (gasoline vapors escape from the vehicle's fuel tank while the tank is being filled).

1.5.2. Factors influencing Motor Vehicle Emissions

Air pollutant emissions resulting from motor vehicle activities are affected by technological, behavioral, and institutional factors. Due to relatively higher average temperatures, poor fuel quality, poor vehicle maintenance culture, and high proportion of old vehicles, the level of emissions from mobile sources are usually high.¹⁵

a. Technological Factors

Vehicle Characteristics: A vehicle's engine type and technology (type of transmission system; engine design features stroke, fuel category, fuel injection and turbo charging); its efficiency (exhaust, crankcase, and evaporative emission control systems – catalytic converters, exhaust gas recirculation, air injection, Stage II and other vapor recovery systems); its engine mechanical condition, adequacy of maintenance; compatibility to alternative fuels; air conditioning system; and deterioration characteristics of emission control equipment are determinants of the magnitude and type of vehicular emissions.¹⁶

Fuel Characteristics: Fuel composition can have a substantial impact on vehicle tailpipe and evaporative emissions. Type of fuel influences the emission pattern of pollutants from a vehicle. Fuel properties and quality which are characterized by the level of contamination, additives (sulfur, lead), chemical composition and content (e.g., oxygen, gasoline octane, diesel cetane, aromatics, and olefin)¹⁷

b. Behavioral Factors

Vehicle use patterns (type of vehicle, number and length of trips, cold starts, speed and loading); choice of mode for passenger/goods movements; and aggressiveness of driving behavior are significant determinants of vehicular emission with regard to behavioral factors in utilization of motor vehicles.¹⁸

c. Environmental Factors

Environmental factors can be characterized by sensitivity of local ecosystems, climatic conditions (ambient temperature, humidity, wind, rain, etc.); topographical conditions (hills, valleys, etc.) which affect diffusion/dilution of pollutants and formation of secondary pollutants. These have a large direct effect on volatile hydrocarbon emissions. Colder ambient temperatures can worsen emissions causing cold start and make faster cooling during short stops by influencing catalytic converters. Hotter ambient temperatures can also have indirect impact on exhaust emissions due to increased engine load from use of air conditioner.¹⁹

d. Institutional Factors

Population density and underdevelopment of transportation infrastructure are one of the main factors affecting vehicular emissions as far as institutional concern is engaged. Legal instruments may need to be formulated to control fuel composition according to the local context within a country as a strategy to reduce emissions. Additionally, such instruments can be applied to support systems in transport demand management; road traffic control and vehicle fitness inspection; capacity and quality maintenance of road infrastructure; fleet maintenance programs; emission standards; age profile of the vehicle fleet and air quality monitoring.²⁰

1.5.3. Major pollutants from vehicular emission

The main pollutant gases include SO₂, NO_x and PM. Petrol engines without TWC (Three-way Catalytic converters) emit CO, NO_x, VOC, and particulate matter than TWC enabled petrol engines, and even diesel engines emit these components in lesser amounts. However, diesel engines, when compared to TWC-enabled engines, are known for emitting more NO_x but lesser CO₂, CO and VOC.

Vehicles use fossil fuel types as a source of energy. The main fuel types used for vehicles are diesel and petrol. Different engines emit pollutants at different magnitudes. The common engines are diesel, petrol with TWC, and petrol without catalyst.

Diesel exhaust is a highly complex mixture of gases, vapors and particles (soot) consisting of a very large number of elements and compounds. Diesel PM has been found to be carcinogenic in animal experimental studies and associations between lung cancer and whole diesel exhausts have been demonstrated in limited human epidemiological studies. The main air pollutants from diesel exhausts that are considered important in terms of their human health effects are: NO₂, Formaldehyde, CO, PM; and the main air pollutants associated with petrol engines are: CO, PM smaller than 2.5 microns, Lead.²¹

a. Nitrogen Oxide (NO_x)

Among highly reactive gas groups, Nitrogen dioxide (NO₂) is one comprising nitrogen and oxygen in varying amounts (collectively known as nitrogen oxide, or NO_x). Many of these gases are colorless and odorless. But one, nitrogen dioxide (NO₂), often is seen along with particle pollution as a reddish-brown layer in the air over urban areas. Nitrogen oxide gases are produced by high-temperature fuel combustion. Nitrogen oxides react with other pollutants to form ground-level ozone.²²

b. Ground-Level Ozone

A gas composed of three oxygen atoms, Ozone, can be either beneficial or harmful to our health depending on where it forms - many miles above ground in the Earth's upper atmosphere (Good Ozone that protects the earth from ultraviolet rays emitting from the sun); or near ground level (Bad Ozone, that is a dangerous air pollutant and main component in "smog"). Ozone is formed when oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) emitted by cars, and other sources react chemically in the presence of heat and sunlight.²³

c. Sulfur Dioxide (SO₂)

The presence of sulfur in diesel fuel results in the emission of sulfur dioxide (SO₂) and PM from the exhaust of diesel-fueled vehicles. Metal sulfates and sulfuric acid in the form of PM constitute 1 to 3 % sulfur emissions from heavy-duty diesel-fueled vehicles and 3 to 5 % of sulfur emissions from light-duty diesel fueled vehicles. Simply, it can be created by burning of sulfur containing diesel fuel.²⁴

d. Carbon Monoxide (CO)

Carbon monoxide is a poisonous gas formed as a result of incomplete burning of fuels. CO is a colorless and odorless gas which is hazardous to human health, and even deadly when concentrated. Around 60 percent of all carbon monoxide emissions worldwide and up to 95 percent in cities are contributed by vehicular exhaust. Areas with heavy traffic congestion in particular experience concentrations of carbon monoxide.²⁵

e. Particulate Matter (PM)

Particulate matter (PM) is formed as mixture of solids and liquid droplets emitted from their sources. Some particles are emitted directly; others are formed in the atmosphere when other pollutants react. Particles come in a wide range of sizes. They can be classified as fine particles (PM_{2.5} – particles up to 2.5 microns in diameter which can penetrate deeply into the lungs and accumulate in the respiratory system); and coarse particles (PM₁₀ – particles between 2.5 and 10 microns in diameter which are emitted from other sources than vehicles).²⁶

f. Hydrocarbons (HC)

Hydrocarbons are formed when fuels are not burnt completely. These pollutants react with nitrogen oxide to form ground-level ozone with the presence of sunlight. Exhaust from diesel engines contains lower concentrations of some gaseous pollutants but higher

concentrations of particulate bearing organic extracts including polycyclic aromatic hydrocarbons.²⁷

1.5.4. Controlling Mechanisms

a. *Policy Framework and Institutional Capacity*

In order to formulate policy frameworks regarding reduction of vehicular emission and meet their objectives effectively, governments need to ensure best institutional systems design which addresses best emission standards and testing procedures; compliance with local context of socioeconomic and environmental values; plus sufficiency of financial, technological, and political support. As a first priority to reducing vehicular emission, policymakers must consider elimination of lead in gasoline, control of Reid Vapor Pressure, and reduction of sulfur content in fuels.

Policy frameworks can be further strengthened through the consideration of alternative energy, adaptation of international conventions, sustainability and public awareness, transport demand management, capacity and quality of road infrastructures, road traffic control and vehicle fitness inspection, emission standards and air quality monitoring.

b. *Motor Vehicle Emission and Ambient Air Quality Standards*

To maintain acceptable level of air quality, major sources of ambient pollutant emission sources should be controlled. At the global level, mobile sources constitute to more than 90% of the total ambient air pollution. In most developing countries, motor vehicle emission is aggravated due to poor vehicle maintenance culture and importation of old vehicles which are classified as super emitters with high level of dangerous pollutants release.

Setting standards for motor vehicle emissions and minimum ambient air quality is vital for a nation's accountability assurance as far as good governance is concerned. Hence, legal instruments to regulate such standards shall be derived from firm environmental protection policies. Many countries have ratified international conventions on air pollution reduction strategies and adopted them into their national contexts.²⁸

c. *Vehicular Emission Testing*

Vehicular emission testing helps to follow up on how minimum air quality standards are met and to understand where the level of ambient air quality is maintained. It also helps in informing policymakers and implementers on necessary measures that need to be taken to alleviate any adverse situations posed against the existing air quality.

Public awareness is a major factor in ensuring the successfulness of emissions control strategies. Awareness by and cooperation from the public has to be supplemented by forceful implementation of control measures. Drivers are key implementers in this regard. Being accountable for timely inspection and carrying out of due maintenance procedures is expected from them. Smoky vehicles should be reported by citizens to concerned bodies and corrective measures shall be enforced.²⁹

d. Appliance of Improved Technology

Improved vehicle technology is one key to reducing air pollution caused by the transportation sector. Better engine models with improved emission controlling technologies are emerging into the car industry.

Catalytic Converters: one of the most effective vehicular emission control devices available. It processes exhaust to remove pollutants, achieving considerably lower emissions than is possible with in-cylinder techniques.

Fuel injection systems: provide rapid and precise control of air-fuel ratio. Fuel is provided to the injectors at constant pressure by a pump and pressure regulating valve. The injectors are solenoid valves, which are controlled by the engine computer. The computer controls the quantity of fuel injected by varying the length of time the valve remains open during each revolution of the crankshaft. This reduces emissions as compared with carburetors.³⁰

e. Improving Fuel Quality and Introduction of Alternative Fuels

Fuels containing unnecessary matters or those of lower quality, directly contribute to concentrated emission of vehicular pollutants. Promotion of the use of environmental-friendly fuels is another key factor determining control of vehicular emissions. In addition, refining contaminated fuels can reduce the degree of vehicular pollution.³¹

f. Inspection and Maintenance Systems

In order to ensure efficiency of motor vehicles regarding their polluting ability, they should undergo periodic inspection and maintenance programs. However this is subject to the owner's level of behavioral and economic capability.

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2. CHAPTER TWO – Existing Framework to Control Vehicular Emissions

2.1. International Protocols and Treaties Signed by Ethiopia

Following the establishment of many initiatives by the international community, member nations have ratified and adopted the protocols to apply into their national strategies from the environmental perspective. Ethiopia has signed different protocols and made efforts to incorporate them into national environmental policies. Some of the international protocols and conventions regarding air pollution signed by Ethiopia include: the Kyoto Protocol to United Nations Framework Convention on Climate Change (UNFCCC) and the Vienna Convention of on the Protection of the Ozone Layer.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change strengthens the international response to climate change, and promotes the Convention's ultimate objective of preventing "dangerous anthropogenic [human-made] interference with the climate system"; The United Nations Framework Convention on Climate Change (UNFCCC) refers to the international agreement that targets industrial and other emissions of greenhouse gases such as carbon dioxide. The UNFCCC is the centerpiece of global efforts to combat global warming. The UNFCCC was adopted in 1992 at the Rio de Janeiro "Earth Summit" and entered into force on March 21, 1994.

The UNFCCC sets its ultimate objective as "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human-made) interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner". The Vienna convention refers to the United Nations Environment program's (UNEP) convention on the Protection of the Ozone Layer, adopted by the governments of the world in 1985.

UN member nations agreed to protect the ozone layer through the Vienna Convention by taking "appropriate measures... to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the Ozone Layer.", to cooperate in scientific research, and to improve the understanding of atmospheric protection mechanisms contained in the Convention. The measures are left unspecified as they can be contextually different in determining the amount and type of harmful substances affecting the ozone layer except the CFCs annexed to the treaty, where they are mentioned as chemicals that should be monitored.¹

2.2. The Practice of Other Countries in Vehicular Emission

In the thirty-year history of vehicle emission control efforts, motor vehicle emissions were first seen from the perspective of visible smoke, then carbon monoxide, and later on hydrocarbons and oxides of

nitrogen. The promotion of unleaded gasoline and sulfur-free diesel fuels received increasing attention. By the mid-1970s most industrialized countries had implemented some form of vehicle emission control program. The main international systems of vehicle emission standards and test procedures are those of North America and Europe. Additionally, the emission of particulate matter and carcinogens like benzene and formaldehyde are now coming under control. Crankcase hydrocarbon controls were introduced into light-duty vehicles in the early 1960s, and exhaust carbon monoxide and hydrocarbon standards were introduced later in that decade²

A series of efforts by the United States and the European Union have been made in recognition to the threat of climate change and potential oil shortages intensified globally. However, standards have remained unchanged for nearly a quarter century from the early 80s to late 2000s until many countries including European countries, Japan, and recently China and the State of California of the US moved forward in establishing or tightening GHG or fuel economy standards.³

2.2.1. U.S. Standards

The United States was the first country to establish fuel economy standards for passenger vehicles after the 1970's oil crisis and California was the first U.S. state to develop motor vehicles emission standards. Because of the severe air quality problems in Los Angeles, California remains the only state with the authority to establish its own emission Standard adopted at the U.S. federal level. The 1970 Clean Air Act lays the foundation for national effort to control motor vehicle pollution which required a 90 percent reduction in emissions of carbon monoxide, hydrocarbons, and nitrogen oxides from automobiles. Because of the size of the U.S. auto market, vehicles meeting U.S. emission standards are available from most international manufacturers. For this reason, and because U.S. standards are generally considered the most innovative, many other countries have adopted U.S. standards. In addition to exhaust emission standards, U.S. regulations address many other emission-related issues, including control of evaporative emissions, fuel vapor emissions from vehicle refueling, emissions durability requirements, emissions warranty, in-use surveillance of emissions performance, and recall of vehicles found not to be in compliance.⁴

The California legislation also authorized the granting of emission reduction credits for any reductions in GHG emissions achieved in model year 2000 through 2008 vehicles built prior to the date the regulations take effect. Under the early credit proposal, manufacturer fleet average emissions for model years 2000 to 2008 were compared to the near-term standard on a cumulative basis. Manufacturers that had cumulative emissions below the near-term standards earned credits. Similarly, credits can be accumulated during the phase-in years and used to offset compliance shortfalls up to one year after the end of the phase-in at full value, or at a discounted rate in the second and third year after the end of the phase-in.

2.2.2. European Union (EU) Standards

In light of its commitment under the Kyoto protocol of the UNFCCC to regulate carbon dioxide emissions from vehicles, The European Union shifted its style of fuel strategy from consumption-focused to emission-focused. This strategy was favored by an interrelated relationship of carbon dioxide emissions with combustion of gasoline and diesel fuels. Individual member states have varying reporting units when labeling vehicles on the market. The attempt of voluntary emission reduction target policies to achieving energy efficiency practiced by the EU could not bring significant improvements in vehicle fuel efficiency. The effect of increased traffic and car size had not reached its target of neutralizing the effects of vehicular emissions.

EU further strengthened its efforts towards regulating automakers by adopting Regulation [EC] No. 443/2009 of the European Parliament and of the Council stipulating that by 2012, the fleet average to be achieved by all cars registered in the EU shall be 130gCO₂/km. Additionally, 10 gCO₂/km in savings had to be achieved through the implementation of: i) use of biofuels; ii) gear shifting reminders; iii) efficient air conditioners; iv) low rolling resistance tires; v) tire pressure monitoring; and vi) a limit curve for light commercial vehicles. Other important policy to reduce the intensity of CO₂ in driving cars is the EU's test procedure for quantifying emissions of vehicles that use electricity, which should be ready to be applied by 2014. To that effect, manufacturers are granted credits up to 7 gCO₂/km of emission if they equip their vehicles with these technologies. Furthermore, for car manufacturers of vehicles that are known as "supercars" emitting less than 50 gCO₂/km, there are incentives provided.⁵

2.3. Existing Legislative Frameworks in Ethiopia

2.3.1. Constitution

As economic advancement increases in a country environmental pollution becomes a territorial and trans-boundary threat seriously affecting local and neighboring population. As a result, this environmental issue is subjected to fundamental rights. By cumulative reading of Articles 44 (1) and 92 (1) of the constitution, which are stated respectively as:

"All persons have the right to a clean and healthy environment." and

"Government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment."

we understand that government is responsible for its citizens in helping them exercise their right under Art 44 (1).

Generally, the phrase "...clean and healthy environment" in the above article applies to the emission of any harmful matter that could directly or indirectly contaminate the environment and harm human wellbeing. Such threat on the country should be an issue for the government to control air pollution

because the constitution states these rights as “fundamental right”. The constitutional provision is more shaped as a general provision.

2.3.2. Policies and Strategies for Reducing air Pollution

a. Strategic Approaches

When developing an emission control strategy, different and interrelated issues need to be addressed in a way that ensures the reduction of vehicular emissions. These measures can be technology-oriented; technically manageable; or systemic. As urban settings are more prone to the fate of ground level concentration of ozone and other pollutants, vehicular emission control strategies should be determined in the broader context of improving outdoor air quality. Technical analysis of the local economy should be seen in the context of air quality management programs. The World Bank’s Air Quality Management System is among these programs which help identify the best alternatives in using scarce resources and address air quality problem.⁶

Technical strategy seeks to minimize the emissions released from motor vehicles using the transport system by intervening with the vehicles being used and the fuels they are burning. Technical strategy addresses per unit emissions rather than the amount of activity causing the emissions. Exclusive application of technological or systemic approaches may not be enough to address the growing trend in vehicular emissions, for a number of reasons. First, technology gains are determined by rapidly growing activities. Secondly, technological advancements can aggravate the growth in activity. Thirdly, it may result in significant over-investment in technology compared with a socially optimum solution which addresses behavioral change.⁷

Vehicle maintenance is a crucial part of any technical strategy to reduce per kilometer emissions of pollutants, both because the proportion of in-use vehicles is substantial compared with new vehicles in any given year, and because of the vigilance required to ensure that exhaust after-treatment technology is well maintained and remains functional.⁸

Three key elements determine effective technical strategies regarding vehicle maintenance: *emissions testing* – provides a mechanism to identify vehicles that are not performing according to regulations; *driver education and training* – important in facilitating the acceptance of emissions testing components, such as inspection and maintenance programs, and because such training can specifically target high-kilometer drivers; *ongoing product liability program* – for either manufacturers or importers, which

might also help to ensure better maintenance by creating a market incentive for suppliers to follow up on their products.⁹

The Ethiopian Environment Policy, under its key guiding principles item n, states that policy makers, government officials and the population should promote awareness and the adoption of a "conservation culture" in environmental matters among all levels of society and ensure that development activities minimize pollution impacts on the environment.¹⁰

Technological strategy regarding vehicles is concerned with:

1. ***Technological improvement or change:*** local capacity limits technological improvements to vehicles especially when considering the availability of appropriate fuel for the technology, and proficiencies for maintenance. Local circumstances and fuel strategies should be consulted when designing the strategies. These strategies may take into consideration the improvements in conventional engine technologies and fuel systems. Technological improvements might also involve the adoption and use of alternative fuel. In Ethiopia, alternative fuels especially biofuel technology is given emphasis. The adoption, adaption, development and dissemination of efficient use of appropriate and affordable technologies which use renewable and non-renewable resources are highlighted in the Environment Policy of Ethiopia.¹¹

2. ***Rate of change of technology in the vehicle fleet:*** Though too expensive in Ethiopia's context, rate of change of vehicle technology can be influenced by encouraging vehicle turnover, ideally through well-designed adjustments to the fiscal regime under which cars are taxed over their lifetimes, or through vehicle retrofitting programs which allow old vehicles to benefit from emerging technology depending on whether gasoline or diesel vehicles and individual or fleet owners are targeted. A narrative report from a Workshop on Promotion of Clean Fuels and Vehicles organized by FfE and UNEP (held on July 22, 2008 in Addis Ababa) mentioned the attempt on retiring old vehicles as "*There was need to seek the views of the public before commencing with the proposal to remove old vehicles from the transport system. This would also provide information on the public response and possible timing of such an initiative.*" A key informant from EPA noted in his speech that retrofitting and retiring old cars can be gradually promoted and that the authority is working on researches.

Technological strategy regarding fuel: fuel improvements are as important as improvements to vehicles. Moreover, the effects of these types of fuel content changes are immediate. Improvements to fuel specifications affect emissions in three ways – reducing emission of certain pollutants such as lead, sulfates, oxides of sulfur (SO_x), or VOCs; facilitating the use of certain exhaust after-treatment technologies particularly those using platinum-based catalysts; and varying costs passed to the consumer unlike the costs for technical improvements to vehicles.

As part of its GTP the government of Ethiopia aims to build a green economy, which promotes cost-efficient abatement potential through the use of energy efficient technologies in the transport and industrial sectors. The government plans to:¹²

- Introduce stricter fuel efficiency standards for passenger and cargo transportation and promote the purchase of hybrid and electric vehicles to counter the low efficiency of the existing vehicle fleet
- Construct an electric rail network – powered by renewable energy – to substitute road freight transport
- Improve urban transport in Addis Ababa by introducing urban electric rail, and enabling fast and efficient bus transit
- Substitute imported fossil fuels with domestically produced biodiesel and bioethanol.

b. The Role of International Community

The issue of air pollution is seriously taken by the international community including the United Nations, the multilateral development banks, and bilateral aid agencies, which helped cities in developing countries to address transportation emissions through a number of different programs. These programs include policy lobbying and advocacy systemic change for sustainable development, exchanging ideas, undertaking common assessment and critical analysis of the state of the UNFCCC climate negotiations and propose new and creative ways of designing legal instruments. Ethiopia's development is also complemented by sources of international environmental funding, such as "Fast Start" funding, CDMs, and voluntary markets.¹³

Much of the practical work in countries regarding air quality control has focused on assistance with assessment and economic evaluation of the problem, including prioritization of investments for air quality mitigation. A number of crucial needs, however, are still under-served by the international community.¹⁴

c. Environment Policy of Ethiopia

The overall objective of the policy is to improve and enhance the health quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human made and cultural resources so that the needs of present generation can be met without compromising the ability of future generation to meet their own needs.¹⁵

The policy aims to maintain a sustained healthy and productive environment with view to protect the interests of citizens and their diverse cultural heritage by employing participatory environmental management, efficient resource utilization and cost-effective controlling mechanism of air pollution.

The Ethiopian sectorial policy on atmospheric pollution emphasizes the following issues:¹⁶

- Promoting climate monitoring program
- Taking appropriate control measures against climate change
- Recognizing that Ethiopia's environmental and long-term economic interests and its energy prospect coincide with minimized atmospheric inputs of greenhouse gases
- Protecting the ozone layer as highlands of Ethiopia already have a thin protective atmosphere
- Ensuring maximum and continued use of biomass for energy production through agricultural interventions

The main objective of the policy lies into two broad perspectives: precaution and polluter-pays principles¹⁷. It prefers to prevent before any damage happens to the environment, and in case of occurrence of such damages, it suggests to make 'the damage' good posing the 'polluter pays' principle onto the polluter¹⁸.

d. Institutional Framework

Ethiopia has made noteworthy steps in formulating regulations, strategies, and guidelines for various aspects of environmental management. The Environmental Protection Authority (EPA) is established based on the Conservation Strategy and Environment Policy, which also placed a foundation for a national environmental management framework. Furthermore, regulations, guidelines and mechanisms have been prepared for environmental assessments of investments at the federal level.¹⁹

Institutional framework should ensure the availability and proper functionality of responsible actors for the quality of ambient air. Institutional development, in line with integration of environmental criteria into transport and urban planning, and support for long-run assessments of alternative investment scenarios, must address the implementation of policies, strategies, laws and regulations at different levels. Under the Ethiopian Environment Policy, the mandate and responsibilities were given to the Environment Protection Authority. The authority closely works with key stakeholders including governmental bodies listed below:²⁰

The Ethiopian Environment Protection Authority (EPA) is the main actor in regulating, standardizing and implementation of Environment protection issues. Therefore, the

authority makes its own effort by implementing minimum ambient air quality standards (see Table 3: GUIDELINE AIR QUALITY STANDARDS).

The Ethiopian Petroleum Enterprise (EPE) operates under the auspices of the Ministry of Trade and Industry and plays the key role in procurement, importing, management and distribution of petroleum throughout the country. The enterprise puts its own efforts to ensure importation and distribution of quality fuels²¹.

The Ethiopian Transport Authority is working with EPE to set guidelines on vehicular emissions, but this has not yet come up with any concrete result. ETA is the main actor in charge of regulation, control, management and standardizing transportation. Certifying imported cars for taxation based on their competency and issuing annual inspection certificate to in use vehicles are ETA's significant roles in addressing environmental protection.

Customs Authority of Ethiopia (ECA) is responsible for regulating taxation.

The Addis Ababa Environmental Protection Authority is responsible for issuing emission standards for industrial and mobile sources in order to protect the environment from pollution.

All the above government bodies work together with EPA to effect the minimization of air pollution.²²

2.3.3. *Legislation*

Based on environmental protection proclamation number 300/2002 of Federal Democratic Republic of Ethiopia, the Environmental Protection Authority (EPA) is granted the authority, based on scientific and environmental principles, to formulate standards that specify the ambient air quality and allowable amounts of emission by stationary and mobile air pollution sources. These standards are already formulated and being implemented. To this effect, EPA has assigned environmental inspectors who are accountable for the responsibilities stated under article 8 of this proclamation²³. These inspectors, according to article 8, perform their duties as per the outlines set against their responsibilities which involve enforcing the implementation of the proclamation; verifying documentation and perform sample tests related to pollutant emissions; and seizing the operation of the pollution source without any court order.

In addition to the above proclamation, proclamation number 468/2005 endorses the Ethiopian Transport Authority the duty of preparing, submission, and upon approval, implementation of standards related to the smoke, gas, vapor and the like emitted from exhaust pipes of vehicles and train

in consideration with the capacity of the country and appropriate international standards. To this effect a new automated system is implemented to assist in annual technical inspection procedures²⁴. The automated systems are controlled primarily by private firms who have signed an agreement with the authority²⁵. According to the directive, the authority issues first level notice to the vehicle owner to take correction measures, and, upon denial, a first level three-month ban will take effect followed by a secondary ban of six months. Any further lag to take correction measures by the owner will lead to termination of the license²⁶.

Compliance of vehicles in relation to environmental pollution protection standards is stated under vehicle identification, inspection and registration proclamation number 681/2010.

2.3.4. Regulations

To the effect of environmental protection proclamation number 300/2002 of Federal Democratic Republic of Ethiopia, EPA is the forerunner in initiating the formulation of applicable regulations by regional environmental protection authorities. EPA provides guidance to respective bodies on how to manipulate the Environmental Protection Proclamation. Detail regulatory frameworks especially in regard to Addis Ababa City Administration's vehicular pollution and ambient air quality standards will be dealt in the next chapter. Higher emphasis will be given to imported second handed cars that are aged enough to cause serious pollution.

¹ECA/FSSD/CFSSD/6/12, ECONOMIC COMMISSION FOR AFRICA, August 2009

Endnotes

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¹⁰Key Guiding Principles: Environmental Policy of Ethiopia, paragraph 'n', Page 6

¹¹HilaweLakew, Ethiopian Energy Sector Review, 2008, Pages 90-92

¹²Ethiopia's Climate-Resilient Green Economy: Green economy strategy, FDRE, 2011, Page 37

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¹⁴Global Overview on Fuel Efficiency and Motor Vehicle Emission Standards: Policy Options and Perspectives for International Cooperation, UN Department of Economic and Social Affairs, May 2011

¹⁵Environmental Policy of Ethiopia, Page 18

¹⁶Ibid

¹⁷TsegaiBerhane and MerhatibebTeklemedhin, Environmental Law Teaching Material, 2008, pages 40-42

¹⁸Ibid

¹⁹Environmental Management Programme of the Plan for Accelerated Sustainable Development to Eradicate Poverty-2011-2015, Environment Protection Authority of Ethiopia, 2020, Pages 3-16

²⁰Proclamation No. 295/2002 article 6

²¹Supra notes 10, pages 90-95

²²From an interview with W/roYetmyetBerhanu, Chair, Sectorial Technical Committee (STC) and a key informant from Ministry of Transport

²³ Proclamation number 300/2002 Art 8

²⁴Directive No. 1/2004 of annual vehicle inspection implementation guideline, page 21

²⁵Ibid

²⁶Ibid

3. CHAPTER THREE – Measures Taken to Control Vehicular Emissions Caused by Imported Second- hand Cars in Addis Ababa

“These days, Addis Ababans are increasingly worried at the ‘smogdd’ (a combination of smoke, fog, dirt and dust) that hangs over Addis. It is a threat to the health of the unborn, the young and the old, all the same. The human costs are indeed staggering in the long term. Simply said, Addis Ababa has failed to limit emissions from factories, diesel cars and trucks.”¹

Addis Ababa is one of the continent’s fastest growing cities in Africa. Around 30 percent of the total urban population of Ethiopia resides in Addis Ababa². This number has nearly doubled every decade. According to the UNHABITAT, the city’s population increased from 1,412,575 in 1984, to 2,112,737 in 1994 and is currently thought to be 4 million. This number is estimated to continue to reach 12 million by 2024³. The rapid population growth of Addis Ababa has been putting tremendous pressures on the city, especially in terms of public and environmental health problems caused by air pollution. Polluted air causes respiratory diseases like asthma, throat & lung infections, heart diseases, dermatological effects, premature deaths, infant deaths and IQ loss in children. It also affects the environment by forming soot, acid rain, corrosion, ozone depletion, and loss of biodiversity.⁴

The city enjoys relatively lesser ambient air quality than other major cities of Ethiopia. However, there is no indication that the environmental regulators believe that the residents now have "enough" air quality. Vehicular emissions have become the single largest source of urban air pollution in Ethiopia and are contributing significantly to health hazards which have grown into a major environmental concern for policy makers.⁵ The enforcement of environmental standard remains weak as the transportation continues to contribute to high levels of air pollution⁶. Air pollution as a result of vehicular emission is poorly managed, and is becoming growing concern in Addis Ababa.

Ethiopia’s vehicle market is supplied mainly by second hand vehicles. The import of new vehicles has a minor role and locally produced ones are less demanded by the user for reasons associated, but not limited to, frustration regarding quality and resale value.⁷ According to a statistical data obtained from the Addis Ababa Transport Branch office, by 2011, the number of imported cars has reached 257,936. Most vehicles would have entered the country with their factory-fitted functional catalytic converters because their origin would be Europe⁸. However, due to the pertaining leaded gasoline, these catalytic converters are left intact while operating in Ethiopia. They are probably destroyed by the lead additive. The nature of Ethiopian vehicle market caused an exhibited preference for older vehicle imports (towards 15 years old rather than ten years) with most likely poorer performance in terms of emissions. The use of unleaded gasoline would bring remarkable benefits to air quality and public health while the use of catalytic converters in cars would be meaningful⁹.

The import of second-hand cars is highly increasing every year. In 2007 alone the number of vehicles imported from abroad has increased by 17.2% to be 167,391¹⁰. In the same year from the total population of vehicles, 53% were more than 20 years old¹¹. This makes the vehicles to be even more polluting. The growing number of older vehicles contribute a larger than per-capita share of emissions. Second hand vehicles have typically already done significant mileage and are usually aged above 15 years.¹²

Currently, no regulations are in place to govern the quality of imported new or second hand vehicles, their age or the extent of their emissions. Taking into account the many advantages for the transport sector, the market's dependence on second hand vehicles needs to be reviewed to ensure improvement on the quality and level of technology over time.

3.1. Regulations and Standards for Vehicular Emission Control

Based on the requirements of Federal Environment Protection Authority, the Addis Ababa Environment Protection Authority (AAEPA) is responsible and mandated for the design of city policy, regulations, standards, capacity building and monitoring of environmental concerns¹³. Measures in controlling vehicular emissions can comprise developing standards for vehicular emission, to regulate the fuel import and build compliance, bearing in mind the cost implications of low sulfur fuels that have higher quality but have higher prices¹⁴. AAEPA is in the process of developing policies, regulations and guidelines specific to the city, and thus currently using several federal policy and regulations. These include:¹⁵

- The overall Environmental Policy;
- The Environmental Impact Assessment Proclamation;
- Pollution Control Proclamation;
- The Public Health Proclamation and National Sanitation Strategy;

The municipal regulations in existence include:

- The structure plan of the city;
- Environmental Audit Regulation;
- Draft Environmental Impact Assessment (EIA), and pollution control regulation; and
- Draft Industrial Effluent Emission, and Ambient, Air and Water Quality Control regulation.

"The total number of vehicles registered in Addis Ababa in the year 2007 was estimated to be 167,391: this figure corresponds to about 75 percent of the total vehicles in Ethiopia. The data also indicated that 53 percent of the total vehicles in Addis Ababa were more than 20 years old.

These old vehicles, particularly those with diesel-powered engines, generally have low engine efficiency and consume more fuel per kilometer than modern vehicles, thereby contributing significantly to the air pollution in the city."

*Abiyu & Getaneh (2009)
Traffic Air Pollution in
Addis Ababa and Its Impacts*

Vehicular emission standard: the proposed Ethiopian Vehicular Emission Standard, which is approved in 2003, sets minimum ambient air quality standards and emission limits for SO₂, NO₂, CO, O₃, PM₁₀, PM_{2.5}, and Lead under the federal EPA while AAEPa set only two city-specific standards – for smoke and CO (Tables 1 and 2).

Parameter	Limit value
Total particulates	
Coal	500 mg/Nm ³
Fuel oil	250 mg/Nm ³
Gas	50 mg/Nm ³
Nitrogen oxides (as NO ₂)	
Coal	700 mg/Nm ³
Fuel oil	1000 mg/Nm ³
Gas	400 mg/Nm ³
Sulphur oxides (as SO ₂)	
Coal	4300 mg/Nm ³
Fuel oil	5100 mg/Nm ³
Gas	100 mg/Nm ³
Carbon monoxide	150 mg/Nm ³
Smoke	2 units on the Ringleman scale

Table 2:EMISSION LIMITS FROM COMBUSTION SOURCES¹⁶

Compound	Guideline Value [µg/m ³]	Averaging time
Sulphur dioxide	500	10 minutes
	125	24 hours
	50	1 year
Nitrogen dioxide	200	1 hour
	40	1 year
Carbon monoxide	100 000	15 minutes
	60 000	30 minutes
	30 000	1 hour
	10 000	8 hours
Ozone	120	8 hours
Suspended Particulate Matter		
PM ₁₀	50	1 year
	150	24 hours
PM _{2.5}	15	1 year
	65	24 hours
Lead	0.5	1 year

Table 3: GUIDELINE AIR QUALITY STANDARDS¹⁷

Parameter	Maximum permissible limit		Measuring method
Smoke	2 units on the Ringlemann Scale during engine acceleration mode.		To be compared with Ringlemann Chart at a distance of 6 meters or more.
Carbon Monoxide	New Vehicles.	Used Vehicles.	Under idling conditions: Non
	4.5 % of the exhaust volume	6 % of the exhaust volume	dispersive infrared detection through gas analyzer.

Table 4: STANDARDS FOR MOTOR VEHICLE EXHAUST¹⁸

In addition to applying the above mentioned tools the city shall, according to regulation number 25/2007, art 7/2, regulate and implement the environmental standards set by the international community as far as local regulations are not readily available.

The Addis Ababa City Government Environmental Pollution Control Regulation Number 25/2007,art 6/3a further elaborates minimum air quality standard determinants in terms of the wellness of human health, animals, plants and materials. The regulation identified specific areas of air quality standard for measurement – Minimum air quality standards, amount of harmful pollutant materials, and amount of pollution emitted from mobile and stationary sources.¹⁹ Article 8/1c, prohibits the emission of pollutant into the air exceeding the amount stated under the motor vehicle exhaust standards. Furthermore, such act against this regulation will result in legal accountability.

3.1.1. Enforcement

a. The Role of Environmental Inspectors

One important concern included in the Addis Ababa City Government Environmental Pollution Control Regulation Number 25/2007 (*see annex A*) is the role of Environmental Inspectors. The regulation authorizes Environmental Inspectors to inspect, without restriction, the status of any vehicle in regard to its compliance with the regulation. Their mandate extends to the extent of seizing licenses and freezing the vehicle when proving that the vehicle is found to be emitting unacceptable level or beyond the limits of the vehicular emission standard.

According to the regulation No. 25/2007, the authority established environmental laboratory as to execute duties entrusted to it. Tests could be subject to redone based on court order. In order to carryout emission test tasks, there has to be fully functional facility and experts trained in the area. However, according to Ato Dereje Bekele, Environmental Consultant

and Researcher in EPA, the laboratory is not functional yet for reasons tailored to malfunctioning of laboratory equipment which demand a lot of money for repair.

Recently, ETA has established a computerized system for the purpose of annual technical inspection of motor vehicles making the difference visible when compared with previous manual inspection methods²⁰. The newly implemented system is functioning under contracts signed between private firms and the authority. The system examines major technical parts of the vehicle including exhaust emissions: CO, HC, and smoke. This contributes a bit to the overall controlling effort against air pollution. However, currently, the gas exhaust emission test is suspended for at least one year until detail research is conducted and suggestions extracted to determine which emissions to address during inspection²¹.

b. Liability

Civil Liability:According to article 11, persons can sue anyone who violatesthis proclamation without showing any vested interest.²²As per the regulation of the Addis Ababa City Government Environmental Pollution Control article 22, any person violating this regulation shall be liable for reinstating the environment to its former or original situation; and by compensating damage caused on persons and their interest as a result of pollution.In case of violation against of a person's right to clean air as a result of mobile source emission, the vehicle owner is subject to make the damage good²³. However, if the violation is posed against the environment, the regulation does not show applicable procedures on how to reinstate the damaged environment since the term environment is broader in its context and air pollution is an irreversible action.

Based on article 2028 of the civil code, *"Whosoever cause damage to another by an offence shall make it good"* individual claims regarding environmental pollution can be bear to the court for due justice.

Criminal Liability:violation against the environmental pollution regulation will result in criminal liability which is provided under criminal code art 519 as:

- i. *Whoever, in breach of relevant law, discharges pollutants into the environment is punishable with fine not exceeding ten thousand birr, or with rigorousimprisonment not exceeding five years;*
- ii. *Where the pollution has resulted in serious consequences on the health or life of persons or on the environment, the punishment shall be rigorous imprisonment not exceeding ten year;*
- iii. *Where the act of the criminal has infringed a criminal provision entailing a more severe penalty, the provisions on concurrent of crimes shall apply.*

Whoever commits crime against the aforementioned regulation shall be subject to the stated fines. However, from practical experience, violations towards air pollution do not result in court case. This could be due to the unintentionally resulted violation of the regulation. In most cases emissions occur as a byproduct of other economic activities.

c. Right holder's claims

Ethiopia has developed policies and instruments like the country's Constitution which states the right to a clean and healthy environment and right to sustainable development in article 44 and 43; Environmental Policy of Ethiopia which states polluter pays principle, precautionary principle; Pollution Control Proclamation Proc. No. 300/2002 stating that no person shall pollute / cause any other person to pollute the environment by violating the relevant environmental standards; and FEPA formulated practicable air quality standards for both stationary and mobile air pollution sources. In addition, standards for industries and exhaust emission standards for vehicles have been prepared and leaded fuel is banned since 2002.

According to proclamation 300/2007, art 11/1, the right holder to the environment is any person who has vested right. Regulation No 25/2007, art 21/1 states that whenever the right holder wants to raise such legal issue regarding an experienced incidence of any exhaust emission, they shall first report it to the AAEPa. However, when dissatisfied with the decision of AAEPa, they can appeal at a competent court within fifteen days.²⁴

3.1.2. Fuel Efficiency

The fuel efficiency of private autos in the existing fleet is estimated to be 12 liters per 100km.²⁵ The role of promoting clean fuels and introduction of biofuels has a greater impact towards minimization of air pollution especially caused by motor vehicles²⁶. Import of unleaded gasoline and phase down of sulfur, or lowering sulfur levels in diesel fuels to at least 500ppm or less is suggested by the ESA²⁷. However, a relatively lower price for sulfur containing diesel has influenced the implementation of the efficient fuel strategy. The country is still importing sulfur containing fuel despite its severe environmental impact. The need for improved efficiency of fuel use by the transport sector is of crucial importance both from the economic and the environmental points of view²⁸.

As world's fuel price increases the international community including government, NGOs and the private sector started focusing on options to find cleaner and renewable sources of fuels²⁹. The government of Ethiopia is promoting the development of biofuels, which can be demonstrated by the effort applied in producing liquid biofuel at the Fincha Sugar Factory³⁰. Ethanol is produced from molasses, a byproduct in sugar production with a production capacity of 12 million liters of ethanol

annually³¹. Use of ethanol as an alternative for fuel efficiency is also another mechanism adapted to reduce the impact of air pollution and rises of petroleum price³².

To improve the transport fuel supply of Addis Ababa, ethanol has been blended at 5% into gasoline to produce E-5 fuel. It is very important to consider promotion of fuel efficient and cleaner vehicles. This reduces loss of hard currency as most vehicles in Addis Ababa are old and consume unnecessary fuel per kilometer and emit more pollution wasting fuel.³³

The production of biodiesel from jatropha plantation is now remarkably contributing to entertaining the demand for alternative eco-friendly fuel. In 2008, there were about 50 registered developers in Ethiopia of which more than 14 had already started plantations. Since then much of the ethanol has been produced and 5 percent blending made with petrol for automotive consumption. The “Biofuel Development and Utilization Strategy” document had been formulated and released by the ministry of Mining and Energy (MoME)³⁴. This document clearly shows that the intention of biofuel production is mainly related with securing energy alternatives rather than climate change.

“Vehicles that are in use for over 20 years emit 20 times higher than new cars do,”

<http://www.ethiopiainvestor.com/index.php?view=article&catid=69>

3.1.3. Vehicle Efficiency

Along with fuel quality improvement and other mitigation measures to reduce vehicular emissions in Addis Ababa, the use of advanced technologies can contribute a lot for emissions reduction in vehicle fleets. Catalytic converters in gasoline powered engine vehicles play the major role in reducing emissions of CO, HC and NOX while the use of purifiers and filters in diesel powered engine vehicles can reduce particulate and other emissions. Modern cars with gasoline powered engines come with catalytic converters fitted in. However, even the famous brand new car importer in Addis Ababa, MOENCO, prefers the import of vehicles without their catalytic converters fitted. This is mainly because of cost-related reasons and unavailability of standards for imported cars. Catalytic converters reduce the tailpipe emissions of HC, CO and NOX and pollutants emitted with engine exhaust gases.

The low fuel efficiency of vehicle fleet could be improved through the promotion of hybrid and plug-in electric vehicles. Increasing the fleet share of hybrid and plug-in electric vehicles to 7.8% and 8.1% respectively, by 2030 would significantly reduce annual gasoline consumption.

"well tuned-up"	without c.c.	with c.c.
CO (gm/km)	42.67	6.86
VOCs (gm/km)	5.62	0.67
CH4 (gm/km)	0.19	0.04
NOX (gm/km)	2.70	0.52

Table 5: Reduction in Gas Emissions in Vehicles with or without Catalytic Converters³⁵

3.1.4. Public Transport Improvement

Findings resulted from the Urban Transport Study and Preparation of Pilot Project for Addis Ababa identified options, and formulated a Multi-Annual plan, comprising short-range, mid-range, and long-range plans (0 to 5; 5 to 10; and 10 to 20 years respectively). The plan includes Public Mass Transport (PMT) System Development Component comprising the upgrading of Anbassa City Bus Enterprise, introduction of medium capacity Public Mass Transport Technology containing Bus Rapid Transit /Light Rail Transit Systems along prioritized corridors of the city and promotion of Minibus Taxi Services.³⁶

There is an increasing trend in traffic congestion due to low mobility which is caused by insufficient road network.³⁷ Majority of the city's residents are pedestrians being vulnerable to traffic congestion. Public transport takes the biggest share of motorized trips.³⁸ Fuel efficient and cleaner vehicles need to be introduced into the public transport. ³⁹Electrified public transport is becoming a priority to serve the urban society of Addis Ababa in a safer, affordable and modern manner.⁴⁰

3.1.5. Testing Emission Compliance of Second hand Vehicles

Ethiopia's import of cars is mainly characterized by second-hand cars. Average fleet age recorded by these old vehicles is near 20 years and about one-third of the fleet is more than 25 years old.⁴¹ There are arguments made about importation of second-hand cars – minimizing or prohibiting at one hand and accepting the import for the country is economically poor at the other. However, the important thing should be setting standards for the importing of vehicles under permeable conditions. Not all second-hand cars are dangerous polluters. Some can be refurbished with the appliance of improved technology to comply with minimum operability standards.⁴²

To date, there is no standard set or implemented by either parties bearing responsibility of controlling vehicular emission. Based on a key informant interview with Ato Asefa Terefe, vehicle Inspection Officer at the Addis Ababa Transport Authority, vehicles are inspected for roadworthiness at the point of entry to the country. The roadworthiness inspection standard deals mainly with construction, size, weight, equipment and fitness to the proposed purpose. Vehicles also need to pass through annual technical inspection to renew their license. At this stage vehicles are inspected using the newly

established automated system installed at third-party companies who entered into the agreement of issuing compliance certificate to vehicle owners. Exhaust emission is one test carried out at the inspection, though not guided by scientific standards.

The vehicles in existence are emitting hazardous pollutants in an increasing rate as their age of fleet increases day to day. It may be effort demanding to work on in-use old cars. However, less could be demanded to cut the stream at the point of entry or to go through pre-shipment criteria such as by checking the technical conditions of the vehicle to be imported. The second option even gives opportunity to minimize risk of financial loss because the buyer would not pay unless agrees with the type of vehicle to be purchased.

3.2. Incentives Provided to Local Car Manufacturers and Importers of Parts

Support provided to local investors who are engaged in the car assembly and import of auto spare parts would enable the facilitation of abandoning the import of old second-hand cars, hence contributing towards air pollution control. Currently, car manufacturers are emerging in to the country's manufacturing industry. These businesses are concerned in supplying cars equipped with modern technology such as turbo charger, catalytic converter and electric control system. The Addis Ababa City Government regulation No. 25/2007 art. 28 states that incentives will be given to those who prevent and minimize pollution based on the regulation issued by federal government for the implementation of environmental protection proclamation No. 300/2002. These firms are benefiting from incentives regarding facilitation of smooth customs clearance and a relatively easy access to bank loans⁴³.

3.3. Factors Impeding the Implementation of Regulations and Standards

Different tools have been designed to control urban air pollution of Addis Ababa. However, there is a bigger challenge in the implementation process. Implementation of regulations, standards and the use of approaches in controlling vehicular emission has been hampered by several factors including institutional capacity gap, constraints related to coordination between actors, prioritization problems and perception of the society towards cheap prices and resale value.⁴⁴

Conclusion and Recommendation

Conclusion

The overall objective was to develop a solid understanding of air quality in Addis Ababa and the impact of imported second-hand vehicles on air quality. Literature review and key informant interviews from selected stakeholder offices were the main methods employed. International conventions and protocols including the UNFCCC, the Kyoto Protocol, the Vienna Convention; environment protection tools from the FDRE constitution, Federal policies, proclamations, regulations and strategies; and studies, reports, journals and online contents contributed by UNHABITAT, UNFPA, EPA, FfE, WB, EEJA and many more have been consulted to further understand the problem. The import of second-hand aged cars as old as 20 and more years, continues increasingly as the status of legal tools to control air pollution caused by these vehicles remain weak. The problem can be addressed remarkably by enforcing the available standards and other legal instruments.

Recommendations

The impact of emission by old vehicles is much larger than modern transportation. Taking in to account Ethiopia's economic situation, transport improvement programs should consider a long-term reduction plan to the rate of import of second-hand vehicles and introducing cleaner vehicles in one hand and promoting refurbishment systems to the old cars in use on the other. In addition, the following points of concern are recommended:

- Jointly develop with key stakeholders, strict standards and regulations and enforce proper implementation;
- Establish participatory planning, monitoring and review mechanisms to work with concerned bodies by reducing task overlap and improving partnership;
- Enforce the proper implementation of the Air Quality Monitoring system, and Emission Measurement standards;
- Promote the use of cleaner vehicles as well as improve fuel quality and use efficiency;
- Lower tax on new cars and increase tax on old cars (discouraging import of old cars) for it:
 - i. Saves hard currency – volume of fuel import reduces
 - ii. Contributes towards environmental protection – low emission
 - iii. Reduces risk to humans' health – low emission
 - iv. Encourages sustained investment – eg. Local assemblers/factories
 - v. Reduces traffic accident – better performance during driving
 - vi. Maintains road safety – new cars are lighter than old model ones
 - vii. Controls import of unnecessary spare parts

- Enforce set standards for vehicular emission in alignment with the UN/ WHO standards (adopting the WHO vehicular emission standards) to implement national policy;
 - i. proclamations, regulations and guiding directives can be effectively implemented
 - ii. helps monitor regular vehicular emission
 - iii. contributes to eco-tourism
- Cooperation among responsible bodies (Ministry of Transport and Communication, Oil Enterprise, Environmental Protection Authority, Customs Authority) to facilitate:
 - i. smooth working relationships,
 - ii. open a chance to innovative expertise, and
 - iii. research whenever necessary.

Endnotes

¹ BT Costantinos, Copenhagen, Climate Change and Africa, Ethiopian Environment Journalists Association, October 2009

²ISBN: 978-92-1-131982-8, United Nations Human Settlements Programme (UN-HABITAT), 2008, page 7

³Ibid

⁴UNEP, Addis Ababa Highlights, Vol.6, No.8, August 2009

⁵ Ethiopian Environment Review, Forum for Environment, 2010, Page 64

⁶Ibid

⁷From an interview with AtoSisayTerefe, After Sales Coordinator, Lifan Motors and a key informant interview

⁸Abiyu Shiferaw and GetanehGebre, Traffic Air Pollution in Addis Ababa and its Impacts, 2009, page 20

⁹Ibid

¹⁰Ibid

¹¹Ibid

¹²Ibid

¹³Regulation No 25/2007, art 4

¹⁴HilaweLakew, Ethiopian Energy Sector Review, 2008, Page 95-97

¹⁵ Addis Ababa City Government Environmental Pollution Control Regulation No. 25/2007 art 4

¹⁶ PROVISIONAL STANDARDS FOR INDUSTRIAL POLLUTION CONTROL IN ETHIOPIA, 2011

¹⁷ GUIDLINE AMBIENT ENVIRONMENT STANDARDS FOR ETHIOPIA, EPA and UNIDA, 2003

¹⁸Supra note 9

¹⁹Abiyu Shiferaw and GetanehGebre, Traffic Air pollution In Addis Ababa and its Impacts, July 2009, Pages 11-15

²⁰From an interview made with AtoAssefaTerefe, Vehicle Inspection Team Leader, ETA

²¹Ibid

²² Environmental pollution control proclamation No. 300/2002 art. 11

²³ Supra notes 13, art 22/1/b

²⁴Addis Ababa City Government Environmental Pollution Control Regulation No. 25/2007, art 21/3

²⁵MoT, Climate-Resilient Green Economy (CRGE) Initiative draft document, unpublished, august, 2011

²⁶Supra note 14

²⁷Ibid

²⁸ Tilahun Sahilu and NegussuAklilu, Sulfur Content in Fuels: an Obstacle to Technology, FfE, 2009, pages 2-4

²⁹Ibid

³⁰ Ibid

³¹ Ibid

³² Ibid

³³Supra note 14, pages 95-101

³⁴Ibid

³⁵Ibid

³⁶The Management of Commercial Road Transport in Ethiopia, Private Sector Development Hub/Addis Ababa Chamber of Commerce and Sectorial Associations, 2009, pages 83-86

³⁷Ibid

³⁸Ibid

³⁹Ibid

⁴⁰ Ibid

⁴¹ supra note 19 page 20

⁴² *Ato Assefa Terefe, Vehicle Inspection Team Leader*

⁴³proclamation No 300/2002 art 8

⁴⁴ *W/ro Yetmyet Berhanu, Chair, Sectorial Technical Committee (STC), Ministry of Transport*

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