Chapter 5

Vehicle Management and Emission Control and Maintenance

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Abstract South Africa range 15th as the world largest CO₂ emitter contributing to 1.2% of global emission. During the Kyoto Protocol of 2014, South Africa pledged to reduce its emission by 34% and 42% in 2020 and 2025 respectively. This study is a combination of literature review from South Africa with particular emphasis on road transport. The focus was on vehicle emission with reference to Limpopo Province to demonstrate how emissions from primarily the use of diesel and petrol as one of the major contributors to CO₂ emission in the province are vital for the sustainability debate. The methodology used to illustrate the dangers of vehicular emissions were based on statistical estimates from the Department of Environmental Affairs (DEA) inventory report from 2000 to 2010. The information used in assessing the vehicle emission standards in Limpopo were obtained from DEA. The findings from literature reviews in general and the results from the field survey from Limpopo Province shed some light on South Africa's vehicle emissions policy issues and standards. Also the analysis focused on the impact of vehicular fleet management and carbon emissions. The article concludes by drilling down to vehicle users, motor vehicle repairs, engine over haulers, used engine collection and disposal with respect to their roles in vehicle emission and control in South Africa.

Keywords Vehicle management · Emission control · Vehicle maintenance · Carbon emissions

5.1 Introduction

South African Greenhouse Gas inventory submission to the United Nations Framework Convention on Climate Change (UNFCCC) published in 2014 shows that in 2010 the energy used in the transportation industry contributed to 47.6% MtCO_{2e} or 8.8% of the country's gas emissions excluding emissions from vehicles fuel used on farms. Policies on measurement of vehicles emissions in South Africa have not

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been precise particularly from the laboratories nor in the real world where vehicle users including public transport, locomotives, taxis, private vehicle users etc., do not understand what is emissions control. In addition to this, driving patterns including the use of aging vehicles, irregular vehicle maintenance and poor vehicle operational histories such as un-registered and use of non-road worthy vehicles can increase emissions. Emissions from the transport sector has grown by 32% from 2000 to 2010 (Vosper & Mercure 2007). In the case study from Limpopo, South Africa, vehicle fleets were composed of new and aging vehicles (SAPIA 2008). The ultimate goal of the government is to improve ambient air quality. The emphasis in this chapter is the analysis of vehicle emission and control processes to demonstrate whether vehicle users are in compliance of government policies on vehicle emission control or not. The analysis begins with the definition of what is fuel quality standard. This approach was necessary to unpack the impact of vehicle emission control and management in South Africa. Although the analysis in this chapter looks at what literature has on vehicle management, emission control and management in South Africa, Limpopo Province was used as the case study area to explain whether those in the transport sector understand emission issues in the local context (DES 2010).

5.2 Literature Review

Outlined in the preceding paragraph are the literature reviewed with respect to vehicle management, emission control and management. The literature begins by defining what is fuel quality standard, the standard figures with respect to vehicle emissions in South Africa, before undertaking the discussion of the field survey results.

What is Fuel Quality Standard?

According to the ICCT (2009) technical report on black carbon climate science and appropriate emission control strategies, fuel quality and emission standards are usually underlined with respect to characteristics such as lead and sulphur contents in fuel. The explanation shows that fuel sulphur is one of the culprits responsible for the sharp rise in emission levels. With respect to fuel quality standard, Woolf et al. (2007) indicated that emissions from vehicles that use fuel with lead can cause damage to human organs. In addition to this, lead can damage vehicles in three ways. For example the catalytic converters in a vehicle can be modified by de-activating the catalysts and preventing them from working efficiently to reduce NO_x , CO and HC in the vehicle exhaust. Therefore, the elimination of lead from gasoline is an essential pre-requisite for implementing policy standards to control vehicle emissions (Vosper & Mercure 2007).

Statistical Facts on Vehicle Emission in South Africa

Gas analysing instruments measure the concentration of hydrocarbons (HC), Carbon Monoxide (CO), Nitrogen Oxide (NO_x), and CO_2 . The concentration units relate to the amount of HC, CO_2 to the amount of total air collected i.e. percentage or part per

million (ppm units). For example, mass emissions in towns such as Johannesburg and Polokwane can be calculated as the product of the molecular mass and measured concentration of each pollutant and the total volume of air collected. The emission from vehicles are in grams per kilometer (gpk) emission factors (Minjares & Hon 2012). The review of literature on vehicle emission shows three primary greenhouse gas emission in South Africa from the transport sector from 2000 to 2010 as shown in Table 5.1.

Table 5.1 shows the relative contribution of greenhouse gas emissions from different modes of transportation in South Africa. Note that the contribution of Methane and Nitrogen Oxide in terms of percentage of total accounts for only 2.14% of the total from 2000 to 2010 in South Africa. However, the understanding of the contribution of greenhouse emission will not be complete without considering the contribution of different modes of transport emitters from South Africa, as shown in Table 5.2.

It is clear from Table 5.2 that the figures include emission from Diesel, Liquefied Petroleum Gas (LPQ), and residual fuel oil, Kerosene and petrol consumption from road transport. However, only diesel for rail transport and jet kerosene and Jet gasoline for domestic aviation were considered. Note that electricity used in rail was not factored in the calculation (Roads and Transport Gauteng Province 2014). The statistics from the Department of Energy shows the contribution of other services to greenhouse emission in 2010 excluding emissions from the production of fuel in South Africa is shown in Table 5.3.

Table 5.1 Greenhouse gases emission from 2000 to 2010 in South Africa

Greenhouse gas	Emission (Mt CO _{2e})	% of total emission (%)
Carbon dioxide (CO ₂)	444.21	97.86
Methane (CH ₄)	3.19	0.70
Nitrous oxide (N ₂ O)	0.52	1.44
Total	453.92	99.74

Source Department of Environmental Affairs (DEA) (2014)

Table 5.2 Contribution of different modes of transport emission in 2010

Vehicle mode and energy carrier	% contribution to overall emission (%)
Domestic	7.7
Road (diesel and petrol)	91.2
Rail (diesel only)	1.1
Total	100

Source Department of Environmental Affairs (DEA) (2014)

Table 5.3 Contribution to total transport emission in 2010

Mode	Emission of greenhouse gas in MtCO _{2e}	% contribution to emission (%)
Electricity to run fuel pipeline	0.090 MtCO _{2e}	0.1
Electricity from electric rail	2.800 MtCO _{2e}	4.5
Marine transport (gas and fuel oil)	9.820 MtCO _{2e}	15.6
Domestic aviation (jet kerosene and jet gasoline)	3.665 MtCO _{2e}	5.8
Rail (diesel)	0.524 MtCO _{2e}	0.8
Road (diesel, LPG, residential fuel oil, other kerosene and petrol)	43.411 MtCO _{2e}	15.6
Total	61.14 MtCO _{2e}	42.4

Source IEA (2015), CO₂ emission from fuel combustion: highlights

Table 5.3 shows that greenhouse emission from the transport sector contributed to 42.2% of emissions selected and road transport accounted for 15.6%. Rail and Diesel contributed 0.524 MtCO_{2e} or 0.8%. If emissions from fuel manufacturing is added to the overall emission from the energy used in refineries, including those from SASOL's processing plant will be contributing 42 MtCO_{2e} and South Africa's international marine bunkers emission in 2010 was 9.82 MtCO_{2e} (IEA 2015). However, SASOL's coal to liquids plants are CO₂ intensive making up to half of the contribution to South Africa emissions (IEA 2015).

5.3 Methodology

The methodology to unpack vehicle management, emission control and management in South Africa discusses the concept of emission control in Limpopo Province in the context of greenhouse gases emission reduction in the transport sector with respect to vehicle fleet management, efficient systems and smart information as well as access to green transport. The study advances arguments on emission control, fuel quality standards, and greenhouse emissions in South Africa from 2000 to 2010 to determine the contribution of South Africa in greenhouse emission globally. The study drills down to the case study area in Limpopo province to discuss vehicle management approach in the province. The findings from the literature review and the results from the field survey from Limpopo province shows that vehicle emission control policy is lacking. This was attributed to the high level of carbon emissions in South Africa. The study demonstrates that through dedicated research on vehicle management control, improved emission control and reduced per capita kilometer travelled in a vehicle. The case study in Limpopo shows that public transport could be improved through

the introduction of the Bus Rapid Transport (BRT) in the province, particularly in growth point towns such as Polokwane. The pilot study demonstrates how the potential of adopting the BRT and re-skilling of vehicle repairers, traffic police, and transportation planners could enhance the buy-in of green transport management especially in rural areas. This was demonstrated with the response from the targeted respondents who indicated that awareness campaign and education via improved bus technology, improved understanding of traffic at bus stops, improved payment systems, use of low cost control systems, efficient boarding and alighting facilities will contribute to improved vehicle management, emission control and management.

5.4 Limpopo Province Field Survey Results Discussions

This section uses the research findings from Limpopo Province to unpack inherent variability of vehicle emissions, vehicle technology, vehicle age, vehicle mode to mention just a few, with respect to measurement of vehicle emissions, technology and vehicle model (SEPA 1999a, b).

5.4.1 Difficulty in Measuring Vehicle Emission Variations

The study in Limpopo Province on various modes of transport users as well as petrol, diesel or engine oil uses were factored in. Emissions vary according to the use and the condition of the vehicle. However, the study showed that 40% of the sampled road transport users including traffic officers indicated that vehicle exhaust emission from the engine occur because of unburned fuel, HC and incomplete combustion leading to the emission of NO_x, HC and CO emissions. Majority of the targeted populations' i.e., 79% of the 120 respondents indicated that when vehicles do not function properly due to lack of gadgets to reduce emissions, the result is more emissions. The study shows that vehicle engine sometimes fail to operate as designed due to exhaust aging resulting in rise in emissions depending on the vehicle condition. Outlined below are some of the factors affecting emissions with respect to different modes of transport which include vehicles make or vehicle technology, age or model or year of make, manufacturer, misuse of the vehicle, malfunctioning of the vehicle etc.

5.4.2 The Effect of Vehicle Material Technology on Emission Control

The innovation of new technologies to control greenhouse emission are said to be incorporated in new vehicles in South Africa. However, 56% of the respondents

were not aware of the exhausts gas recirculation to reduce NO_x formulation in the car engines. This can be done in addition to replacement of old carbonators with throttle body and part fuel injections and a computerised inbuilt air–fuel mixing and spark time. With respect to new car dealers that were consulted in the province, it was indicated that some new cars have emission control mechanism inbuilt by certain car manufactures who include them in their designs to promote reduction in emissions, but as the vehicle gets old the emission control efficiency decreases.

The major objective of transportation management is to move product from an origin (i.e., location) to the destination with minimizing cost and reduced negative impact to the environment (Lin 2009; Lin & Ho 2008). Innovation in engine technology for aircraft, locomotives, and trucks can reduce air pollutants and other forms of emissions (Mercure & Lam 2015). Similarly, low combustion chambers can sustainably lower the emissions of NO_x , CO_2 , and unburned hydrocarbons. The development of new aircraft types, alternative fuels and engines with increased fuel efficient hybrid can mitigate the environmental impacts of aircraft operations. According to Lin and Ho, transportation technologies commonly used in logistics industry include transportation information system, global positioning system (GPS), geographic information systems (GIS), radio frequency communication system, and transportation data recorders. The transportation information system and geographical information system can help logistics managers to plan, manage and control transport challenges. The global positioning system, and radio frequency communication system can track and guide drivers during the transportation of products. This argument was supported by Murphy and Posit (2003) on the mitigation of the negative effects of vehicle emissions on the environment by emphasising intermodal transportation logistics using internet tracking system, GPS, and other means to ensure efficiency. Furthermore, they found out that electric and digital logistics management can reduce delivery time, optimize transportation and distribution routes and provide greater flexibility in the used of transportation modes.

The Effect of Age of Vehicles and the Millage Accumulated Over Time on Emission Control

The policy on the age of vehicles in South Africa shows that vehicles older than 10 years should not be on the road as well those with high millage accumulated. This is because the age of the vehicle and millage accumulation tend to increase greenhouse gas emissions. With respect to age of vehicles, 65% of the respondents against 25% agreed that emission discharge is both a function of the normal degradation of the vehicle due to the age and irregular maintenance of the vehicle. 82% of the respondents indicated that lack of regular maintenance of vehicles was one of the major reasons there is increase in vehicle gas emission particularly CO and HC emissions. 38% of the respondents did not have any opinion on whether old vehicles should be discarded. They regarded the age of vehicles as important but added that if the vehicle owner undertakes regular maintenance the vehicle emission will not be as much as irregular maintenance. Taxi drivers, bus owners were unanimous that re-capitalization may not be practicable in rural areas if the aim of the policy is just to reduce carbon emissions because they identified poverty as the main challenge.

5.4.3 The Effect of Vehicle Manufacturing Model on Emission Control

South Africa is not a major car manufacturing country as compared to those from Europe, USA and Asia. However, it is important to note that some car models perform better with respect to vehicle emission than others. With respect to vehicle maintenance, 52.2% of the respondents' indicated that vehicle models and the type of car can exhibit very low gas emission as compared to other vehicle engines that may have emission control facilities inducted in the engine. They indicated that the effectiveness of a vehicle engine in emission control and the life time durability of the car depends on the make, the model and usage, (Wagner & Rutherford 2013).

5.4.4 The Effect of Vehicle Maintenance Culture on Emission Control

The research in Limpopo showed that there is no policy on the degree to which an individual vehicle owner in South Africa should be controlled with respect to vehicle emission and maintenance of his or her vehicle. 46% of car repairers consulted in Limpopo province indicated that regular vehicle maintenance as recommended by the manufacturers can improve the engine emission system. Similarly, 75% of vehicle repairers in the province indicated that informal vehicle repairers such as road-side mechanics can affect the quality of vehicle repairs if the mechanics are not well trained. This is because poor vehicle maintenance can degrade the catalytic convertor or tuning engines which can impact on emissions. In a developing country such as South Africa, sophisticated on board sensors to monitor vehicle performance can be installed in new vehicles. Major car maintenance garages in Limpopo indicated that those who adhere to manufacturers' warranties with respect to maintenance can improve engine performance and extend the life span of the vehicles. Out of 40 vehicle owners contacted including taxi drivers on their service plans, 86% of them indicated that they do not go for regular vehicle maintenance.

5.4.5 The Effect of Misuse and Malfunctioning of Vehicles on Emission Control

The study showed that drivers that do not comply with driving rules and misuse their vehicles can lead to increase in CO₂ emissions. For example, prolonged high-power driving on steep mountain roads can lead to a rise in vehicle engine temperature which is a major cause of pre-mature damage to the catalytic converter and this can result in increase in emissions. Similarly, regular vehicle malfunctioning due to irregular driving habits can in general trigger vehicle malfunctioning with high CO emission

and high HC emission while vehicles with high NO_x emission tend to have relatively low CO and HC emissions. With respect to misuse and malfunctioning of vehicles on emission, the main findings in Limpopo showed that 59% of the respondents agreed that it increases vehicle emissions as compared to vehicles in good working conditions.

5.4.6 The Effect of Driving and Fuel Delivery Engine Load on Emission Control

According to 53% of the respondents in Limpopo province, vehicle emission vary due to changing vehicle engine load. This is because the relationship between emission and load depends on the fuel-delivery and the type of emission-control technology installed in the car engine. This is because NO_x emissions will increase with increasing engine load. Six out of seven motor vehicle formal services centres consulted in Limpopo province, five (5) indicated that enrichment of the air fuel mixture can lead to elevation in CO and HC formations because of inadequate oxygen available for pollutant conversion to CO_2 and water in the catalyst (Foster & Green 1999). Out of seven auto vehicle repairers contacted all of them indicated that steep roads and the installation of air conditioning and heating devices in vehicles can put additional load on the engine and this can affect emissions. The seven auto-mechanics consulted indicated that the way drivers shift gears on vehicle in a non-automatic car can affect emission rates because depending on how the driver presses the pedal, smoothly or excess acceleration can increase emissions.

5.4.7 Vehicle Humidity, Catalyst and Ambient Temperatures and Emission Control

According to Wagner and Shao (2015), catalytic convertors and oxygen sensors of a vehicle are effective at low temperatures. However, when it is heated by the vehicle exhaust, the devices can attain very high temperatures required for the operation of the vehicle after 1–4 min of driving. Similarly, ambient temperature has direct effect on the evaporation of HC emission (Ligterink et al. 2013). This explains why very low temperatures for example, below 20 °F or 3 °C can influence emission of gases at ignition and this may cause the catalyst of some vehicles to cool during stops. As a result of this, very high ambient temperatures of the engine can affect vehicle exhaust emission because engine loads can increase due to the prolonged use of vehicle air conditioners. Similarly, this can lead to higher emission of NO_x . Consequently, the amount of water vapour in the air can affect NO_x in aging and malfunctioning vehicles. Although 43% of the respondents did not understand the complexities, vehicle humidity, catalyst and ambient temperature impact on emission

control, 23% were of the opinion that high temperature can increase NO_x and HC emissions.

5.4.8 Quality of Fuel Used in the Vehicle

In an article on fuel effects in auto/oil high emitting vehicles, (Nunes & Bennett 2009) postulated that the quality content of fuel in the vehicle can have a substantial impact on tied-pipe and evaporative emissions of the vehicle. For example, in urban areas such as Beijing, the authorities introduced oxygenates in fuel to reduce the quantity of CO emissions during the winter to decrease the volatility as well as reduce evaporative HC emissions during hot seasons. The study in Limpopo province did not go as far as unpacking the evaporative components of the emissions but fuel stations consulted in South Africa showed that, the concern is on the sulphur content of the fuel (Jumadi & Zailani 2011) and (Murphy & Posit 2003). The practice of standardizing fuel quality in South Africa is to make sure that fuel consumption no matter the make of the vehicle, capacity and geographical location have access to the same category of the fuel. This practice is to ensure a year-round gasoline standard across the county with respect to emission control as a strategy. However, it is important to note that the emission of vehicles at the province are difficult to measure. However, with respect to the concerns raised by the respondents on awareness campaign, 86% of them indicated that it is important to determine in the future the relevant policy and regulatory frameworks on the use of hybrid vehicles in South Africa, (Technology Fuels Green Efforts 2003).

5.4.9 Inspection of Vehicles in Limpopo Province

Measures to track malfunctioning vehicles in Limpopo Province and in South Africa in general are undertaken by road traffic officers during road inspection of vehicles. However, 83% of the commuters indicated that traffic officers were more concerned with driving offences such as drink-driving, over-speeding, overflowing than checking vehicle emissions. A trajectory of 56 road traffic officers and private car owners were requested to indicate their observations with respect to vehicle inspection in 2016, in line with a similar exercise by (Istrfi & Chico 2013). Their responses are shown in Table 5.4.

The investigation in Limpopo did not deal directly with the measurements of the distribution of vehicle with respect to HC emission because the emphasis was on respondents experiences with categories of testing in the province. In order to ascertain the opinion of traffic officers, private car owners and vehicle repairers were targeted to provide their experience in the last 5 years with vehicle testing in the categories indicated. The same questions were administered to all the respondents to ensure the validity of the answers and to cross-check contradictory answers. What

Table 5.4 Respondents experience with vehicle licensing in Limpopo Province, 2016

Category of respondents	Number of respondents	District	Municipalities	Vehicle test categories				
				Vehicle test category	Meet standard	%	Did not meet standard	%
Traffic Officers	6	Vhembe	Thulamela	No. of vehicles tested for road traffic offenders	30	53.6	26	46.6
Truck Drivers	8	Sekhukhune	Tubatse	Over speeding	46	82	10	17.9
Taxi Drivers	10	Mopani	Greater Giyani	Vehicle emission check	51	91.15	5	8.9
Bus Drivers	6	Waterberg	Polokwane	Number of vehicles observed with exhaust smoke	21	37.5		62.5
Private car owners	10	Capricorn	Mogalakwena	Vehicle road worthiness checks	54	94	3	5.1
Total	56							

Authors field data, 2016

was interesting in the Limpopo field survey was that 53.6% of the respondents as against 46.4% indicated that road traffic officers do conduct checks but without devices by merely undertaking observation inspection of the vehicles. 52% of the traffic officers interviewed in Limpopo province indicated that most of their routine checks on vehicles were mainly for reckless driving, and over-speeding. The most interesting part was when the respondents were requested to indicate whether they have experienced vehicle emission checks by traffic officers and 91.1% of them as against 8.9% indicated none. This means that the priority for road traffic officers were centred on roads accidents avoidance than the inspection of vehicles to determine greenhouse emission levels as indicated by a similar study conducted in China.

5.4.9.1 Enforcement of Traffic Regulations in Limpopo Province

On the enforcement of traffic regulation, 92% of the respondents indicated that to drive a car in South Africa, one must go through a stringent driving test. The study showed that the accumulation of driving distance i.e., per capita km travelled can increase greenhouse emissions. In the rural areas of Limpopo where vehicle checks are less frequent, vehicles older than 10 years were still in use in 2016. 67% of the respondents indicated that they have owned motor-vehicles which were out of their service plans. In a study conducted by (Vashon & Klassen 2006) on vehicle emission and testing it was discovered that 50% of total vehicle emitting CO and HC in rural areas were from vehicles older than 10 years. The study in Limpopo showed that 47% of the respondents were not in favour of scrapping vehicles older than 10 years in Limpopo because according to them it will affect those who earn less than R3500.00 per month and own a car. The reasons they gave for not scrapping old vehicles was that those who spent more than 10% of their disposable income on transport cannot afford to have their vehicle scrapped (Vashon & Klassen 2006). If vehicles older than 10 years were scrapped in Limpopo province, majority of the vehicles in the rural areas will be phased out but carbon emissions will be reduced. In addition to this, most taxis, buses and private vehicle owners depend on such old vehicles to commute and make a means of livelihood in the rural areas (SEPA 1999a, b).

5.5 Recommendations

The literature on vehicular emission shows that the subject is very wide and complex. However, the literature review and the field study results also showed that as a developing country, South Africa should in the nearest future focus on the prospects of green transport technology to ensure that compliance and control over vehicle emission is achieved to reduce greenhouse emission. With respect to the vehicle management, emission control and management in Limpopo province, 82% of the respondents indicated that with respect to green transport economy there is need to re-skill those in the transport industry with respect to hybrid vehicles. This will

Table 5.5 Relevant skills required to upscale the control of emission in a green transport economy

Skills suggested based on the findings	Elements of the skills
Green IT technology (technicians and GIS experts)	To learn new softwares relevant to green transport technology and interpretation of graphics symbols
Emission control handling skills (technical experts: electrical, chemists, safety technicians etc.)	To be able to operate and test equipment such as batteries, bio-fuel, electrical wires etc. To be able to identify motor vehicle emission levels and their effects on the environment
Heavy vehicle emission systems repair procedures for biofuel (mechanics/biofuel technicians, electricians etc.)	To be able to repair heavy vehicle that use bio-fuel and undertake post repair testing to ensure control
Skills on moto vehicle emission control legislations and standards setting (legal experts)	Training on new legislations that may be needed when green energy transport technologies are introduced
Moto vehicle green standards skills (greens skills traffic control officers)	To be able to undertake visual inspections of vehicle emission control system such as particulates filters, catalytic converters, crankcase ventilation. In addition to this be able to detect excessive emissions i.e. hydrocarbons, carbon monoxide, oxide of nitrogen and also examine excessive consumption of fuel
Green vehicle component repair skills (general mechanic skills)	To be able to undertake green transport vehicle component repairs skills such as removal of parts, replace and adjustment procedures, dismantle, repair re-assemble and adjustment procedures

require an awareness campaign and the redesign of curriculums in transport related fields of study. Table 5.5 shows some of the relevant skills that may be required in the future.

Table 5.5 shows some of the skills that will be needed to enhance new green transport technologies such as hybrid cars, bio-fuel cars, emission control mechanisms and software etc.

5.6 Conclusions

The study in Limpopo province on vehicle management, emission control and management in South Africa has showed that measuring greenhouse gas emissions is still in its infancy. In addition to this, several issues complicate the subject because new vehicle technologies will be required to ensure stricter fuel quality to gradually improve the situations. The case study in Limpopo province and the desktop review of literature have shown that the quality of existing fuel falls below the hybrid vehicles in terms of emission control. Vehicle emission control in South Africa will require

stricter vehicle emission standards to be implemented step by step taking along all the stakeholders in the transport industry. The study showed that awareness campaigns on emission control need to be emphasised to sensitise people on current emission standard in the province and in South Africa in general. These require re-skilling across the whole value chain in the transport sector. Similarly to enforce vehicle emissions in South Africa will require policies that will carry along the stakeholders in terms of re-skilling.

The advantage with hybrid vehicles is that they have the potential to reduce emission by 25 MtCO_{2e} per amount by 2050 (Mercure & Lam 2015). The cost of savings will account for R385 per ton, CO_{2e} for petrol with the use of plug-in hybrid electric vehicles. It is pertinent to note that more research to explain the concept of green transport to the public is needed i.e., workshops. The introduction of new hybrid cars in the nearest future with respect to management of transportation systems should focus on regulating urban transport via the introduction of the BRT and improvements of road network quality, improving transport operation conditions and enforcing gradually stricter regulations and standards with respect to old vehicles in rural areas of South Africa.

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