Towards a greener economy:
A critical review of South Africa's policy and legislative responses to transport greening

by

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DEDICATION

To my late daughter Slungelo Nomvelo Ninela, a former BSc: Environmental Sciences graduate of the University of KwaZulu-Natal, and a former BSc: Honours graduate in Environmental Management, at the University of South Africa, who passed away tragically on 9 July 2018. Your dream was to have a PhD degree of your own. Wherever you are girl, you are dearly loved and will always be missed. You inspired me not to give up on this one.

Also, to the late "Ken" Saro-Wiwa, who died fighting for the environmental rights of Nigeria's people of Ogoni, may his soul rest in peace.

DECLARATION

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Exact wording of the title of the thesis as appearing on the electronic copy submitted for examination:

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I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

Signature

09 September 2019

Date

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Finally, I wish to acknowledge the following extract from a speech in the film, *On Deadly Grounds* (1994), by actor, musician and environmentalist, Steven Seagal, which contributed to inspiring the initiation and researching of the South African government responses to transport greening:

> I would love to start off by saying, thank you to the brothers and sisters who have come here today representing this course. I've been asked by Mr Ittok and the tribal council to speak to you and the press about the injustices brought against us by some government officials and big business. How many of you out there have heard of alternative engines … engines that can run on anything from alcohol to garbage or water? Or carburetors that can get hundreds of miles to the gallon? Or electric or magnetic engines that can

practically run forever? You do not know about them because if they were to come into use, they would put the oil companies out of business. The concept of the internal combustion engine has been obsolete for over 50 years. But because of the oil cartels and corrupt government regulation, we and the rest of the world have been forced to use gasoline for over 100 years. Big business is primarily responsible for destroying the water we drink, the air we breathe and the food we eat. They have no care for the world they destroy. Only for the money they make in the process. How many oil spills can we endure? Millions and millions of gallons of oil are destroying the ocean and the many forms of life it supports. Among these is plankton, which supplies 60 to 90% of the earth's oxygen. It supports the entire marine ecosystem, which forms the basis of our planet's food supply, but the plankton is dying. I thought well, let's go to some remote state or country. Anywhere on earth. But, in doing a little research, I realised that these people broker toxic waste all over the world. They basically control the legislation and in fact they control the laws. The law says no company can be fined over $25000 a day. If a company is making $10 million/ day by dumping lethal toxic waste into the ocean, it is only good business to continue doing this. They influence the media so that they can control our minds. They made it a crime to speak for ourselves. If we do so, we are called conspiracy nuts and we are laughed at. We are angry because we are all being chemically and genetically damaged and we don't even realise it. Unfortunately, this will affect our children. We go to work every day, and right under our noses, we see our car and the car in front of us spewing noxious poisonous gases that are all accumulative poisons. These poisons will kill us slowly even if we see no effect. How many of us would have believed if we were told 20 years ago that one certain day we would not be able to see 50 feet in front of us, that we would not be able to take a deep breath because the earth would be a mess of poison gas, that we would not drink out of our faucets, that we would have to buy water out of bottles? Our most common and God given rights have been taken away from us. Unfortunately, the reality of our lives is so grim that nobody wants to hear it. I have been asked what we can do. I think we need a responsible body of people that can actually represent us rather than big business. This body of people must not allow the introduction of anything into our environment that is not biodegradable or able to be chemically neutralised upon production. Finally, as long as there is profit to be made from the polluting of our earth, companies and individuals will continue to do what they want. We have to force these companies to operate safely and responsibly with all our best interests in mind so that when they don't, we can take back our resources and our hearts and our minds and do what is right (*On Deadly Grounds*, 1994).

ABSTRACT

As a sub-component of "green economy", "the green transport" phrase is used interchangeably with eco-mobility, sustainable transport and clean transport. It has gained momentum as a way of addressing several socio-economic and environmental challenges associated with the conventional fossil-based transportation systems. Governments across the world have since developed policies and financial support mechanisms to pursue a greener transportation path. As a player in the global system, South Africa is expected to play a particular role. While research has been conducted in South Africa on various themes of transport greening, there seemed to be a lack of academic, integrated and comprehensive analyses of policy responses to these themes. This research thus sought to investigate and provide insight on the government's responses to the transport greening revolution. It sought to benchmark this country against leading global players, making recommendations on policy directions for five transport greening themes: fuel quality, fuel economy, fuel switch, technology switch and non-motorised transportation. The aim was to contribute to the green economy body of knowledge, while assisting in guiding policy direction to enhance the country's response system to the transport greening transition. Primary data were collected from interviews largely with representatives of key government departments at national and provincial levels as well as from attendance at various government and industry fora. Secondary data were obtained from policy, legislative and regulatory documents as well as official reports. Both primary and secondary data were analysed qualitatively using content analysis and presented using graphic, tabular and verbatim techniques. Using ideas borrowed from interventionist, systems, sustainability and globalisation conceptual frameworks, this research describes how South Africa is lagging behind the rest of the world in terms of transport greening policies and related financial and non-financial support mechanisms. Examples of good practice are nonetheless evident within the governance system. These include the adoption of globally accepted emissions and fuel economy standards, inclusion of transport greening agenda in various domestic legislative and policy frameworks, through to the exemption of certain transport greening products from import and local taxes. Many gaps still exist such as lack of incentives actively stimulating the demand and supply of green transport goods and services. This research therefore calls for more state intervention to address these gaps and strengthen existing policy and legislative frameworks. Due to the small sample of data sources used, the results are not generalisable, but nonetheless provide insight on green transportation and what South African policy makers should consider to improve the status quo.

Keywords: green economy, sustainable transportation, globalisation, government policy, regulatory and legislative interventions

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LIST OF ACRONYMS

APDP	Automotive Production and Development Programme
A-S-I model	Avoid-Shift and Improve model
ASSAF	Academy of Science of South Africa
BEE	Black Economic Empowerment
BEVs	Battery Electric Vehicles
BRICS	Brazil, Russia, India, China and South Africa
BRT	Bus Rapid Transit
CAPEX	Capital Expenditure
CBG	Compressed Biogas
CBU	Completely built up
CEF	Central Energy Fund
CF1 and CFII	Clean Fuels 1 & 2
CKD	Completely knocked down
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CoJ	City of Johannesburg
CSIR	Council for Science and Industrial Research
DEA	Department of Environmental Affairs
DoT	Department of Transport
EFTA	European Free Trade Association
EGR	Exhaust gas recirculation
eNaTis	Electronic National Traffic Information System
ERIA	Economic Research Institute for ASEAN and East Asia
EU	European Union
EVs	Electric Vehicles
FCEVs	Fuel Cell Electric Vehicles
GDP	Growth Domestic Product
GHGs	Green House Gases
GTS	Green Transport Strategy
HEVs	Hybrid Electric Vehicles
ICCT	International Council on Clean Transportation.
ICE	Internal Combustion Engine
IDC	Industrial Development Corporation
IDPs	Integrated Development Plans
IDZs	Industrial Development Zones
IEA	International Energy Agency
IPAP	Industrial Policy Action Plan
kPa	Kilopascals
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LRP	Lead Replacement Petrol
MEC	Member of the Executive Council
Mercosur	South America's Fractious Trade Bloc
MIDP	Motor Industry Development Programme
NAAMSA	National Association of Automotive Manufacturers of South Africa
NEMA	National Environmental Management Act
NGOs	Non-Governmental Organisations
NGVs	Natural Gas Vehicles
NMT	Non-Motorised Transport
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NRCS	National Regulator of Compulsory Specifications
NT	National Treasury
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturers
Pb	Latin plumbum (Lead)
PFMA	Public Finance Management Act
PGMs	Platinum Group Metals

PHEVs	Plug-in Hybrid Electric Vehicles
PICC	Presidential Infrastructure Coordinating Commission
PM	Particulate Matter
PPM	Part per million
PPPFAct	Preferential Procurement Policy Framework Act
PV	Photovoltaic
RAF	Road Accident Fund
REIPPP	Renewable Energy Independent Power Producer Programme
SABS	South Africa Bureau of Standards
SACU	Southern African Customs Union
SADC	Southern African Development Community
SANS	South African National Standards
SANTACO	South Africa National Taxi Council
SAPIA	South African Petroleum Industry Association
SIP	Strategic Infrastructural Projects
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Industry Environment Programme
UNIDO	United Nations Industry Development Organisation
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAT	Value Added Tax
WHO	World Heal Organisation
WTO	World Trade Organisation
WWF	World Wide Fund for Nature

DEFINITIONS OF KEY TERMS

Alternative fuels, refers to any materials or substances that can be used as fuels, other than conventional fuels like fossil fuels.

Anthropocentrism, refers to a philosophical extension of environmental ethics, which stands for a human-centred, as opposed to nature-centred system of value, believing that human beings are the most important entity in the universe.

Avoid-Shift-Improve model, refers to a transportation model which seeks to achieve significant GHG emission reductions, reduced energy consumption, less congestion, with the final objective of creating more liveable cities.

Cleaner Fuels 1 Programme, means the regulations on petroleum products specifications and standards introduced in 2006, towards the production and supply of liquid fuels equivalent to Euro 2 fuel specifications.

Cleaner Fuels 2 Programme, means the regulations on petroleum products specifications and standards introduced in 2012, towards the production and supply of liquid fuels equivalent to Euro 5 fuel specifications.

Conventional transportation, has the same meaning as common, standard or ordinary means of transportation system used in a particular area, and in this thesis, is used largely to refer to automobiles propelled by internal combustion engine- powered fossil fuels.

Ecocentrism, refers to a philosophical extension of environmental ethics, which stand for a nature-centred, as opposed to human-centred system of value.

Electric vehicles, refers to alternative fuel automobiles that use electric motors and motor controllers for propulsion, instead of common propulsion methods such as the internal combustion engine (ICE).

Euro 2, means the acceptable limits for exhaust emissions of new vehicles sold in the European Union and EEA member states which came into effect in1997.

Euro 5, means the acceptable limits for exhaust emissions of new vehicles sold in the European Union and EEA member states which came into effect in 2011.

Fossil fuels, refers to hydrocarbon-containing material of biological origin formed over the course of millions of years and that can be burned for energy.

Fuel switch, means a shift from using fuels produced from fossil fuels to using fuels produced from alternative energy or renewable energy sources.

Globalisation*,* means the increased interconnectedness and interdependence of people and countries.

Glocalisation, refers to the practice of adapting global outlook to local conditions.

Green Economy, refers to growing economic activity (which leads to investment, jobs and competitiveness) in the green industry sector while also shifting the economy as a whole towards cleaner industries and sectors with a low environmental impact.

Green House Gases, refers to those gases in the atmosphere that influence the earth's energy balance, by absorbing and emitting radiant energy within the thermal infrared range.

Green Transportation, refers to any modes of haulage that do not rely on dwindling natural resources, and hence have low negative impact on the biophysical and socio-economic environments.

Interventionism, refers to the doctrine of intervening, especially government interference in the affairs of another state or in domestic economic affairs.

Keynesianism, refers to an economic theory which views government spending as a crucial tool to stimulating consumer demand of goods and services.

Lobbying, refers to any attempt by individuals or private interest groups to influence the decisions of government.

Modal shift, means the replacement of an environmentally unfriendly/ less environmentally friendly mode of transport with the next mode considered to be more environmentally friendly.

Nationally Appropriate Mitigation Action, refers to a set of policies and actions taken by countries towards realising their commitment aimed at reducing greenhouse gas emissions.

Natural gas vehicles, refers to alternative fuel vehicles that use natural gas as fuel rather than the typical liquid gasoline or diesel.

Neoclassical economics, is a broad theory that focuses on supply and demand as the driving forces behind the production, pricing, and consumption of goods and services.

Neoliberalism, refers to an ideology and policy model that emphasises the value of free market competition, and shares resemblance with market-oriented reform policies such as 'eliminating price controls, deregulating capital markets, lowering trade barriers" and reducing state influence in the economy.

Non-motorised transport, means transportation powered by human or animal forms of energy.

Rent seeking, means a practice of manipulating public policy or economic conditions as a strategy for increasing profits or seeking to increase one's share of existing wealth without creating new wealth.

Road accident fund levy, means a tax charged by government on automobile fuel purchased at fuelling stations, which is used as insurance cover to all drivers of motor vehicles in South Africa in respect of liability incurred due to vehicle accidents.

Sustainable development, means development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs.

Technology switch, means a shift from using conventional automobiles to using alternative automobiles powered by energy derived from renewable sources.

Vehicle fuel economy, means the distance travelled using a particular amount of fuel.

Verbatim, means exactly the same words as were used originally.

Zero Emission Vehicles, refers to automobiles that do not emit exhaust gases from the on-board power sources.

CHAPTER ONE

BACKGROUND TO THE RESEARCH PROBLEM

1.1. INTRODUCTION

Located on the southern tip of the continent of Africa, South Africa is a young democracy dating back to the early 1990s. As a democratic state, the rights and well-being of citizens are protected through the rule of law which is well entrenched within the Constitution (Act No. 108 of 1996). Government, according to Slaughter (2017), has a responsibility to take care of its citizens through the provision of goods and services that are not always within the reach of many citizens. In South Africa, this involves prioritisation of many areas of national importance including the provision, regulation and coordination of transportation goods and services for road, rail, nautical and air transit (Department of Transport, 2020). In the provision of transport goods and services, the World Bank's Public-Private-Partnership Legal Resource Center (2019) recognises the effective role and mutual benefit that public-private partnerships (PPPs) can provide in addressing critical transportation problems. As described in the Global Business Knowledge website of the Michigan State University (2020), South Africa has a mixed economy where the private and public sector institutions play important roles in the country's economic affairs. This therefore places this country somewhere between two historically often clashing economic systems (the Keynesianism and the Neoclassical/free-enterprise) and to a certain extent, the neo-liberal state.

The issues become even more complicated when environmental worldviews are added into the country's development equation. There is ecocentrism on one hand, which calls for nature's own right to exist (Beckmann, Kilbourne, van Dam and Pardo, 1997), while anthropocentrism, on the other hand, seeks to protect the bio-physical environment for its value to humans (Bjerke and Kaltenborn, 1999). South Africa's attempts to green the economy are submerged into these economic development versus environmental protection quandaries. The South African Government is hence faced with many critical but competing demands and priorities as highlighted in the 2017 Medium Term Budget Policy Statement (National Treasury, 2017). These include among others, health, basic education, social protection, peace and security, social protection, community development, debt service costs (National Treasury, 2017). A closer look at the country's Constitution (Act No. 108 of 1996) lists public transport as one functional area that cuts across the mandates of Government at national, provincial and local levels.

This chapter introduces the reader to the research conducted to investigate and provide an insight into South Africa's policy, regulatory and legislative responses to green transportation. It provides an introductory background in nine sections including the current section, which is followed by a brief description of the transport sector refereeing to both the international and local realities. Third, the chapter examines challenges linked to this industry. These challenges are cited as the key reasons behind increased concerns, which hence triggered global efforts to promote the transition towards eco-mobility. The fourth and fifth sections introduce the concepts of greening, highlighting various greening technologies adopted globally, while at the same time providing real life examples of such technologies adopted in South Africa. A discussion on the research problem statement is provided in section six, followed by clarification of the scope and rationale for the research. The chapter then outlines the structure of the thesis, introducing all eight chapters and highlighting the linkages between these chapters. Finally, the chapter concludes by providing a summary of key issues covered in the chapter.

1.2. BACKGROUND TO TRANSPORT INDUSTRY

Historically, various modes of transportation have been used including air (aviation, space), land (rail, road, path, underground tunnels and excavations), waterways including rivers and oceans, cable and pipelines. South African History Online (SAHO, 2017) has developed a historical account of the evolution of land-based transportation. Acknowledging that the world's first form of land transportation was indeed walking, thousands of years later, humans used donkeys and horses. This was followed by the invention of the wheel, around 3,500 BC which marked major changes in transportation and travelling. Based on SAHO's account and a very detailed narrative by Demartini (2014), the chronology of events can be summarised as follows:

- walking and swimming;
- use of animals and animal drawn carts, wagons and coaches;
- use of bicycles;
- invention of steam engine and the train; and
- the invention of a motor car right through to the modern, current and future technologies used in land transportation.

Over the years, the global usage of motor vehicles has increased, with the World Health Organisation (WHO, 2017) recording over 1.7 billion registered vehicles across the globe in the period 2011-2014. The growth in demand for motorised travel in the 1990s occurred within the context of rapidly expanding urban populations (Walsh, 1998), hence putting pressure on land that was far away from urban centres. These are locations that were previously considered unsuitable for development, hence increasing the need for motorised travel (Walsh, 1998). In South Africa, this situation was exacerbated by a formalised apartheid planning system that forced black people to live on the periphery of the urban centres away from services and work centres (Barrett, 2003). Twenty-five years since the dawn of democracy, this trend remains, with the country's major cities, according to Vosper and Mercure (2016), having rather continued to grow after the eradication of apartheid-based human settlement policies. Major centres of the economy such as Gauteng, according to Vosper and Mercure (2016), are now characterised by low-density communities that continuously spread outward away from city centres and places of work. Lack of public transportation services in these areas often results in commuters relying heavily on private vehicles or mini-bus taxis when travelling to various areas according to Mackay (2020). This continued urban sprawl therefore means that some of Government's scarce financial resources have to be channelled towards supporting road public transportation as indicated in the budget Vote 35 of National Treasury (2016). Thus the inherited spatial planning legacy continues to play its part against efforts for a just transition to a greener transportation regime.

The use of modern forms of transportation systems, including investments on infrastructure, has nonetheless contributed positively to developing the world's economies (New Zealand Ministry of Transport, 2016). While many modes of transport have become extinct (Demartini, 2014), transportation technology has evolved, allowing faster and more efficient transportation of goods and people to and from different destinations compared to primitive times. It has also employed people and contributed to the gross domestic products (GDPs) of countries as depicted in Trading Economics (2020). In South Africa, the automotive industry has been labelled as a critical part of the domestic economy with its contribution to GDP estimated at 7.5%, when the multipliers are taken into consideration (Barnes, Black, Comrie and Hartogh, 2018).

The transportation industry is one of the sectors that has contributed to various unintended environmental problems faced by the world economies today. Most of these problems can be traced to the transport sector's use of fossil derived fuels. Earth-derived fossil fuels, according to Mia et al. (2011), contribute to about 97% of the world transport energy demands. Markandya and Barbier (2007) noted that the world economy was largely based on the wide availability of these fuels, which were used to power industrial, mining, transport and many other sectors. According to the Institute for Global Environmental Strategies (IGES, 2007), these fuels are going to remain a major transport fuel, with Alexandre (2011) noting their potential increased use in developing countries. Starting with the industry value chain, South Africa's experience with the conventional transport sector is discussed in the following sub-section.

1.2.1. Industry value chain

The South African energy industry, according to the Department of Energy (2018), is dominated by fossil fuels. The industry's value chain comprises the primary, secondary and tertiary sectors, which further include agriculture, mining, manufacturing and service industries (Automotive Industry Export Council, 2017). These can be classified further under three broader segments: downstream activities, core automotive and upstream activities as depicted in Figure 1.1. Raw material mining and beneficiation to produce products like steel, metals, rubber, plastics, glass, fuel, and electronics make up key activities of the upstream chain (AT Kearney, 2020). The production of various Original Equipment Manufacturers (OEM) automotive brands and associated components make up the core automobile segment. The final segment of the chain includes the downstream activities which, according to Kneale (2016), cover various sectors including service sectors, consumers, government, insurance companies. The core automotive sector encompasses all companies that manufacture, sell, repair and recycle motor vehicles and motor vehicle parts and accessories (Mahomedy, 2016).

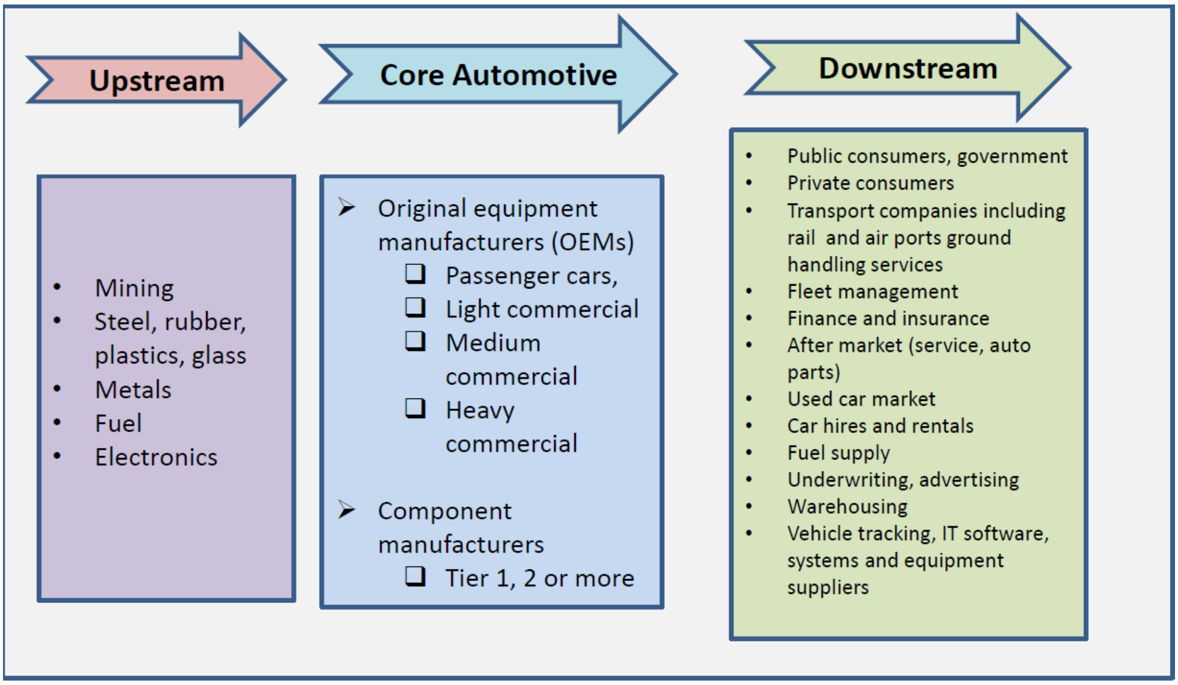

Figure 1.1: South Africa's Automobile Transport Industry Value Chain (adapted by author from AT Kearney, 2020 and the Kingdom of Saudi Arabia Industrial Clusters, 2020)

South Africa manufactures a variety of vehicles, which range from passenger cars, commercial (light, medium, heavy and extra heavy) vehicles and buses. It is a large local automotive industry manufacturing sector (ERC, 2013), which contributed an average of 6.6% of national Growth Domestic Product (GDP) between 1999 and 2009 (Pitot, 2010). In 2018, this number grew to around 7.7% with this being the only sector to have grown in terms of manufacturing while others have shrunk (Naidoo, 2018). Dominated by international OEMs – Toyota, BMW, Ford, Nissan, VW, Mercedes and Isuzu (Mahomedy, 2016) – South Africa assembles internal combustion engine (ICE) powered vehicles and associated components for the domestic and export markets (Automotive Industry Export Council, 2017).

Posada (2018) describes South Africa as the regional leader in Africa in terms of both the production and sale of new automobiles. South Africa's passenger vehicles, according to this author, accounted for about 22.6% of vehicles on the continent in 2015, by far the largest fleet in Africa. The sale of new passenger vehicles in the same year exceeded 412,000 units. This number was therefore about 37% of the African market and 60% more than that of Egypt according to this writer. Posada regards Egypt as the second biggest market for new vehicles in Africa. Statistics from the 2016 Export Manual produced by AIEC (2016) however showed a negative trade balance with respect to trade in components, and a positive trade balance with respect to complete vehicles in the period between 2010 and 2015 as shown in Figure 1.2. This could be due to better and/ or no tariffs on the components, as opposed to the higher tariffs on completely built up vehicles as indicated in the tariff book by the South African Revenue Services (SARS, 2018). This could also be due to the incentives that local automotive producers and exporters obtain through the country's automotive incentive support scheme, described in guidelines developed by the National Department of Trade and Industry (2017).

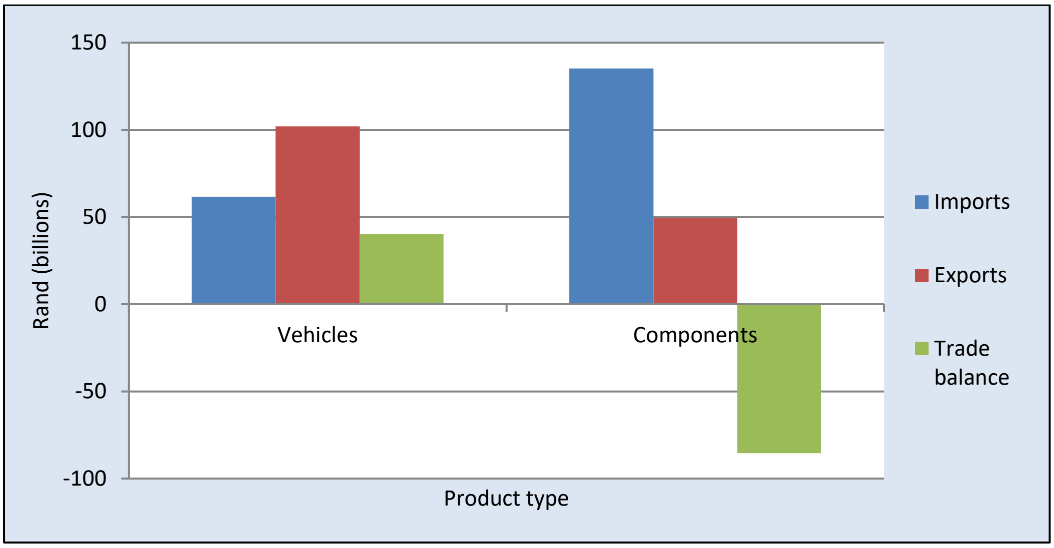

Figure 1.2: Vehicle and components trade balance between 2010 and 2015 (produced by author from 2016 Export Manual data)

The local market for automobile sector products comprise the bus and coach sectors; the road freight sector; Government fleet; the minibus-taxi industry; the air ground handling sector and the private car and / or fleet owners. The World Health Organisation's Global Health Observatory Data Repository recorded over 9.9 million registered vehicles in South Africa by 2013 (World Health Organisation, 2017). Based on data obtained from the country's electronic National Administration Traffic Information System (eNatis), Van der Post (2017) reported figures of around 12 million registered vehicles by February 2017. This showed 21% increase over the past 4-5 years. By December 2019/January 2020, this number was recorded at 12 701 630, approaching 13 million vehicles across all nine provinces of the Republic of South Africa (eNatis, 2020). These sectors all contribute to the country's gross domestic product and hence are critical to Government's objective of growing the country's economy. As noted in the country's Green Transport Strategy, South Africa's road transport industry contributes to the air pollution and greenhouse gas (GHG) emission challenges that face the country (Department of Transport, 2018). Any decision to alter the status quo, including the intensification of transport greening efforts will affect these sectors either positively or adversely. A glimpse of the status of each of these subsectors is provided below.

1.2.2. The bus, coach and road freight sectors

A study conducted by the Industrial Development Corporation (IDC) and the Department of Trade and Industry (**the dti)** (2017) revealed that there are 61,941 registered buses in South Africa. This includes all commuter buses of sizes ranging from 16 seats and more. Minibus-taxis of 14 seats and less are not included in this number. Gauteng has the largest number of buses at around 32%, followed by KwaZulu-Natal at 15.8%, Mpumalanga at 12.85% and the Western Cape at 11%. The bus and coach sector is heavily subsidised by the SA Government – about 50% of bus commuter operator income in 2016 was derived from such subsidies, according to a report by Kneale (2016) of Who Owns Whom. A total of 25,000 buses that Kneale recorded in this report, travelled 1.4 billion kilometres per annum, consuming around 506 million litres per annum of diesel. Like the bus and coach sectors, road freight consumed a substantial amount of petroleum resources, which accounted for about 35% of the total operational costs as shown in Figure 1.3.

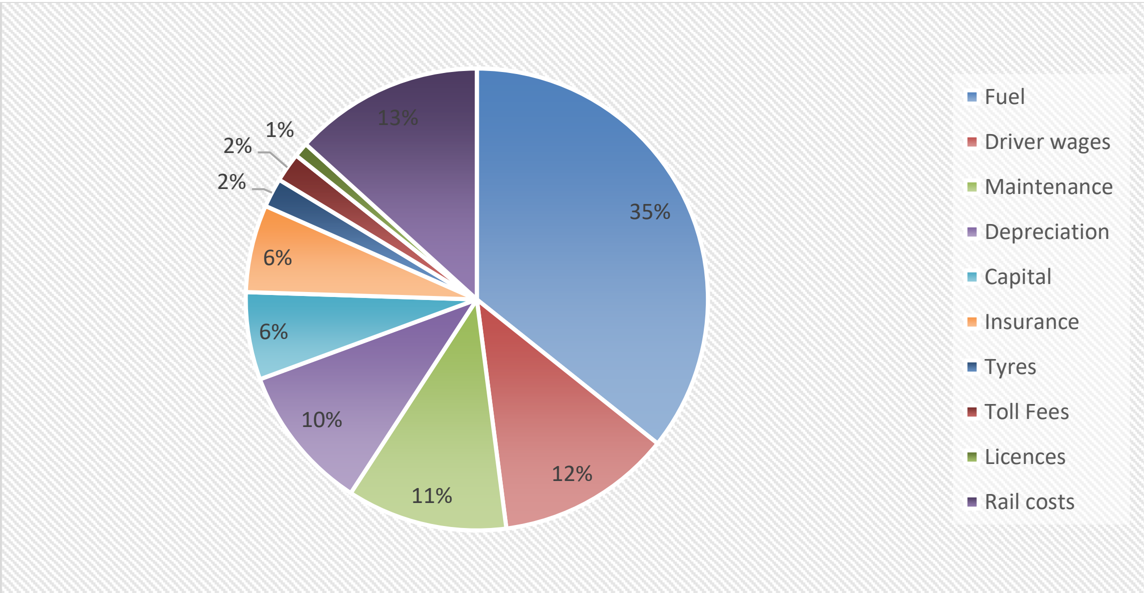

Figure 1.3: South Africa's road freight operational costs in 2013 (produced by author using data extracted from Kneale, 2016)

On average 3,000 trucks travel along the Gauteng-KwaZulu-Natal Johannesburg-Durban corridor every day. Stafford and Faccer (2014) noted that in 2009, a small number of freight (about 11%) was transported by rail network, with the rest relying on road network. This was regardless of the relatively lower prices associated with rail services when carrying and transporting goods in large quantities over long distances. In 2016, Havenga, Simpson, King, de Bod and Braun (2016) of the University of Stellenbosch Logistics Barometer, noted that rail freight accounted for 15%, while road freight accounting for 85%. Stafford and Faccer (2014) also noted that, in general, public transportation systems are not fully utilised. One of the reasons for this, according to these authors, is inconvenience (with public transport systems not available in several informal residential areas).

1.2.3. Government fleet

A company called g-FleeT management, manages the Government fleet in South Africa. Belonging to the Gauteng provincial government (Department of Roads and Transport), this company renders various services. The services include vehicle hire and overall management of fleet services for the South African Government including some local municipality departments, provincial and national departments (Gauteng Provincial Department of Roads and Infrastructure, 2015/2016). In 2015/16, g-Fleet Management made payment of up to R 12,185 million for fleet services. In 2020, this company had a fleet size of about 7,094 vehicles (g-FleeT management, 2020). At the end of their life cycle, this company withdraws the vehicles, selling them at public auctions. These vehicles therefore join a pool of vehicles that South Africa sends to the second-hand vehicle market.

1.2.4. The minibus-taxi industry

The minibus-taxi industry is operated by private taxi owners and regulated by Government. Around 300,000 taxis in 2016 had been issued with permits to operate on the South African roads (Kneale, 2016). They transport over 2 billion passengers/year and about 16 million passengers a day, with an average of 10 hours a day spent on the road (Kneale, 2016). As is the case with the road freight sector discussed above, the minibus-taxi industry also incurs relatively higher costs on fuel consumption than in other operational items as shown in Figure 1.4.

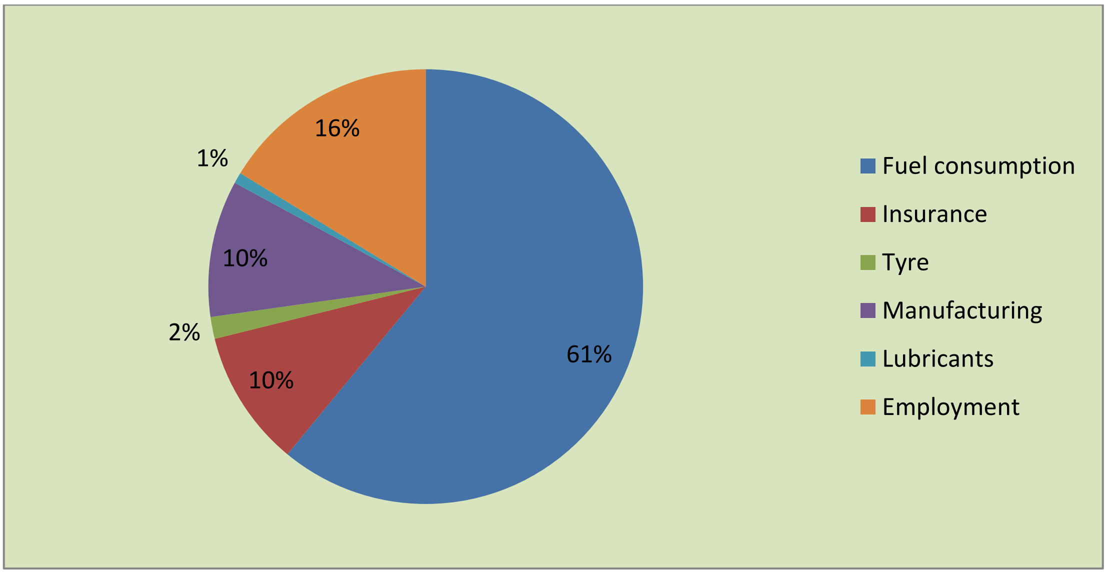

Figure 1.4: Minibus-taxi industry’s annual operational costs in billion Rands/annum (by author using data from Kneale, 2016)

The minibus-taxi industry in South Africa was developed without any assistance from Government. It provides a service to commuters originally from the black townships that are located far away from work areas as a result of the spatial planning legacy from the apartheid government. It also services routes around the South African cities as well as long distances across the provinces. In most cases, it is the only reliable and convenient source of transport. In recent years, this sector has had to undergo a series of transformations through government interventions. In some cases, the owners were paid about R830,000 per taxi as compensation for not operating their vehicles on the routes that were covered by the Bus Rapid Transit (BRT), such as the Rea Vaya bus service system in Johannesburg, the Areyeng at the City of Tshwane and the MyCiTi and the City of Cape town in exchange for jobs or shares.

Kneale (2016) noted statistics provided in the Cape Town MyCiTi project report of 2016. This report according to Kneale, states that a total of 459 minibus-taxis had been taken off Cape Town's roads as part of the BRT project, and 292 of them had been crushed. This report goes on to state that over 571 taxi operating licences had been surrendered, with 74 former taxi drivers now driving buses. Some of these drivers, according to Kneale (2016), are now trained as auto electricians, bus builders and diesel mechanics. Responding in a report submitted to the Competition Commission in 2018, the City of Cape Town's Transport and Urban Development Authority (2018) said:

> Cape Town's MyCiTi BRT service has been relatively successful, carrying about 70 000 passengers per average workday at present (compared, for example, to 55 000 daily on Gautrain); however, the model that was used where minibus-taxis are fully replaced by BRT is not affordable for full rollout across the city and new approaches are now being attempted which are a 'hybrid' between BRT, improved traditional buses (referred to as "quality bus serves") and minibus-taxis. (The City of Cape Town's Transport and Urban Development Authority, 2018: 4)

The impact of the transformation in the minibus-taxi industry required many changes to minimise negative consequences of the transition. The South African National Taxi Council (SANTACO) (2018), in a presentation submitted to the Competition Commission of South Africa, stated that in many instances the Bus Rapid Transit (BRT) is seen as a way to get rid of taxis operating on the affected routes.

1.3. PROBLEMS ASSOCIATED WITH CONVENTIONAL TRANSPORTATION APPROACHES

While it is generally agreed that the transport industry has contributed positively to developing world economies, it has also contributed to many socio-economic and environmental challenges as discussed in this section. In addition, fuel resource scarcity especially in countries that do not have oil reserves of their own, global price volatility and many other challenges, continue to haunt the transportation industry. Mia et al. (2011) noted that due to the earth's limited reserves of fossil fuels, the current approaches to transportation are unsustainable in the long term. These approaches emit greenhouse gases at an increasingly faster rate than any other energy-using sector according to the World Health Organisation (WHO, 2018). The majority of emissions emanate from combustion of fossil fuels. WHO also noted that road transport is a major contributor to local air pollution and smog, reporting early deaths of about 2.4 million/ annum due to outdoor air pollution. While this figure cannot be attributed to the transport sector alone, the transport industry is partly responsible for the most concerning emissions of particulate matter. This is a well-recognised cause of carcinogenic illnesses and respiratory diseases as indicated in a study by the USA National Center for Biotechnology Information (2018).

The transport sector impacts negatively on human lives in many ways including exposure to air pollution, road accidents, laziness, lost family time due to commuting and fuel price rises. Many of these negative impacts affect the poorest groups in society who often do not own and drive any vehicles. The following sub-sections provide a brief overview of South Africa's experience with these challenges. These are negative impacts on socio-economic and ecological environments, which have been the driving force behind calls for improvement in the way this sector conducts its business. One such call has been a need to green this sector as discussed further in section 1.4.

1.3.1. South Africa's fossil fuel consumption and production constraints

In the mobility report produced by Sustainable Mobility for All (2017: 8), the transport sector in 2012 was the major user of energy in nearly 40% of countries of the world. It was also the second largest one in the rest of the world. By 2018, this sector accounted for about 25% of world energy consumption (The Maritime Executive, 2018). In South Africa, the Department of Energy (2018) noted that the country's transport sector consumed around 27% of the country's total energy in 2015, after the manufacturing sector. In the same year, transport accounted for 77% of total petroleum products consumed in the country, with the road segment consuming the largest share of these fuels at around 742,642TJ in 2015 (Department of Energy, 2018). Petroleum products accounted for about 99% of energy used in the transport sector, with electricity accounting for only 1% (Department of Energy, 2018).

The 99% petroleum fuel demand split includes 5% petroleum fuel requirements from gas through the Gas to Liquid (GTL) process, 39% from coal through the Sasol's Fischer-Tropsch Coal to Liquid (CTL) process and 56% from imported liquid fuel/crude oil (DOE, 2018). These figures however are in contradiction with figures presented by McGregor (2015) who claimed that South Africa imports the rest (about 80%) of its petroleum products as crude oil or finished product from the coast of Durban. This implies that South Africa has production capacity of only 20%.

The Department of Trade and Industry (2015) noted that the cost of liquid fuels in the transport industry accounts for almost 50% of the total costs of transportation. Figure 1.5 shows a general increase in diesel consumption from the period 2009-2016, a trend which the Department of Energy (2017) associated with the increased sale and adoption of diesel powered vehicles. The National Association of Automobile Manufacturers of South Africa (NAAMSA), according to Mahomedy (2019), has noted how diesel engine powered vehicles have grown in popularity over recent years. As a percentage of total cars sold between 2014 and 2018, new diesel passenger cars and light commercial vehicles, have grown from around 31% to 36% (Mahomedy, 2019).

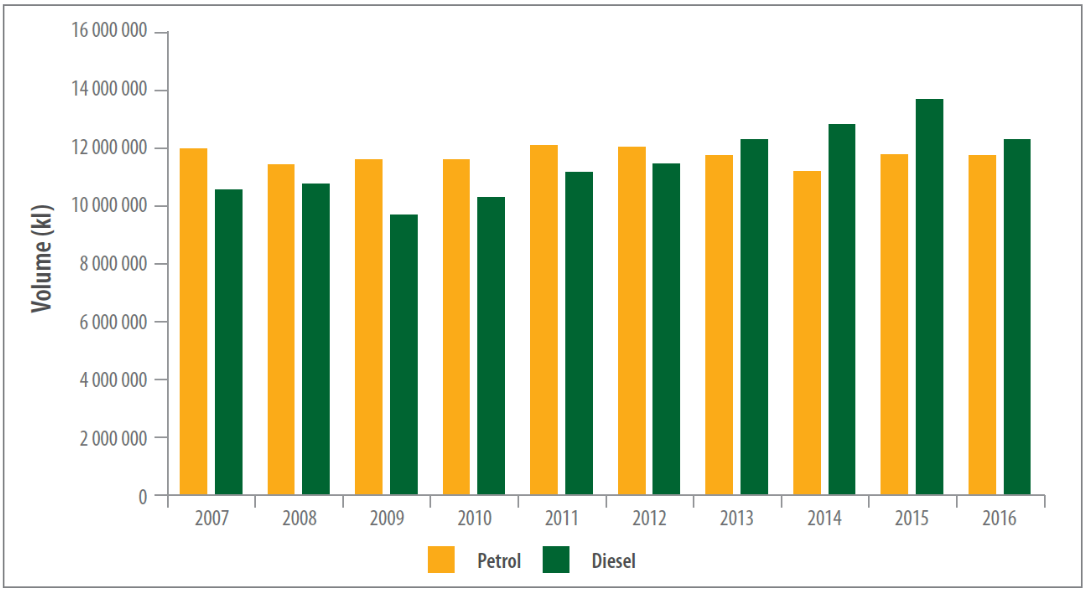

Figure 1.5: Petrol and diesel consumption (Department of Energy, 2017)

South Africa is able to produce its own fuel but only small volumes are produced locally through Sasol and PetroSA synthetic refining of coal and natural gas. While the country has the capability, there are many challenges such as aging refinery infrastructure as alluded to in Donnelly (2018). Disputes between Government and industry on who should foot the bill have meant these refineries have been left aging.

1.3.2. Fossil fuel imports and trade balance challenges

While South Africa has fairly limited oil and natural gas deposits, an abundance of coal reserves have led to the establishment of a well-developed synthetic fuels industry (Department of Energy, 2018). This country is dominated by use of Internal Combustion Engine (ICE) vehicles that are largely powered from fossil fuels. South Africa is among the world's non-oil rich countries; it imported nearly 80% of energy in the form of crude oil in 2008 (Vanderschuren, Jobanputra and Lane, 2008). This has been on the rise, with major suppliers being Nigeria, Saudi Arabia, Angola and the United Arab Emirates contributing about 90% of South Africa's crude oil imports in 2015 (Department of Energy, 2018). These countries have supplied South Africa constantly, with other small players in the market including Equatorial Guinea, Qatar and Kuwait have supplemented supply since 2010.

While crude oil import prices have fluctuated since 2007, they have generally been on the rise alongside a continued increase in exchange rate as shown in Figure 1.6.

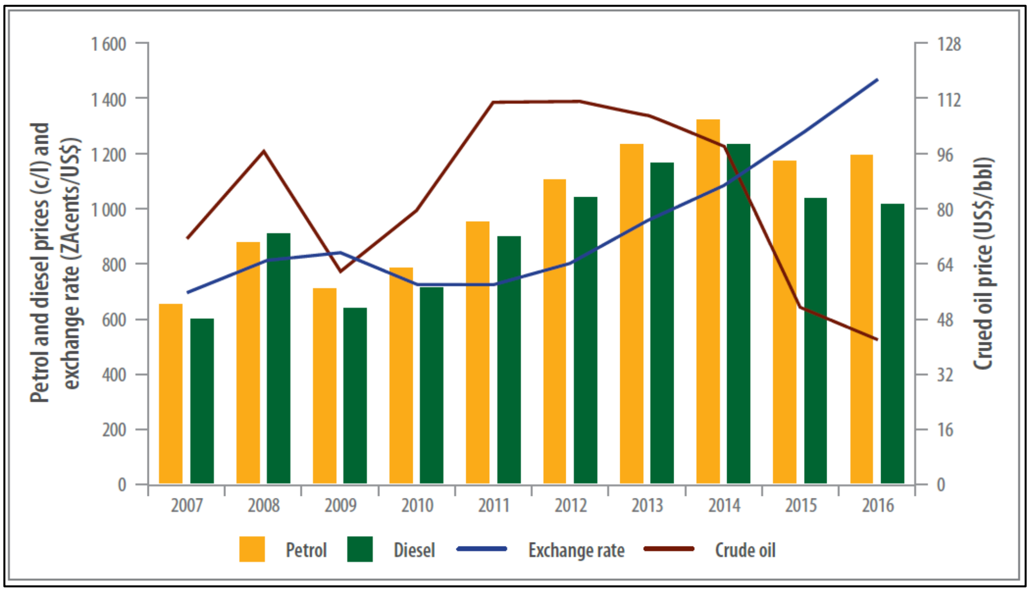

Figure 1.6: Crude oil imports and prices (Department of Energy, 2017:10)

A sharp decline in the price of crude oil from 2014 can be noted in Figure 1.6, while the exchange rate continued to rise. From 2009, the prices of finished petroleum products have also been on the rise, with these prices having also declined slightly from 2014 to 2016. Petrol and diesel fuels represent a substantial amount of imports, as indicated in Figure 1.7, with diesel imports having grown higher than other petroleum products since 2008. These imports have cost the country about 10 times more when the price per gigajoule is compared to the gigajoule price of electricity (Department of Trade and Industry, 2015).

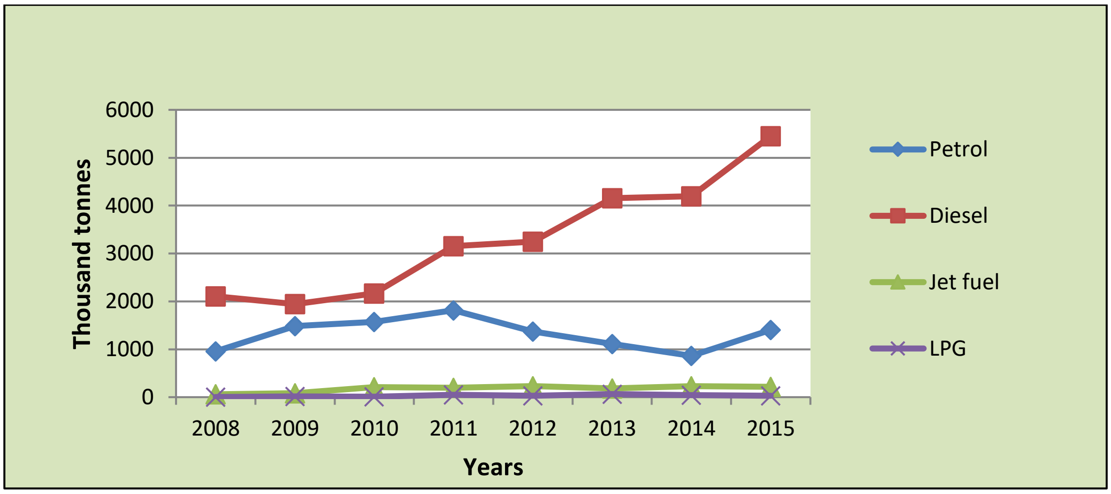

Figure 1.7: Petroleum products imports to SA (by author from SAPIA, 2015)

In order to meet the domestic demand, the Department of Energy (2018) noted that some petroleum products have to be imported to supplement the production shortfall, thus making this country a net importer of transport fuels. The costs of continued reliance on such imported products impacts negatively on the country's trade balance. This country imported petroleum products valued at R 207 billion in 2013 alone (Department of Trade and Industry, 2015). It is a demand, which the Department of Trade and Industry (2015) claimed was around 800 litres per second, costing the country almost R450 million per day in foreign currency. In addition, petroleum products are the largest item on the country's import account, hence impacting significantly on this country's balance of trade account.

As depicted in Figure 1.8, maintaining South Africa's balance of payments required revenue from all of the country's exported mineral resources including gold, platinum, diamond and coal (Department of Trade and Industry, 2015). This figure tells a story about the socio-economic impacts of heavily relying on imported petroleum products. The cost to the South African economy in the form of forgone revenue, lost local employment and negative trade balance, cannot be ignored. Besides detrimental impacts on the country's socio-economic environment, atmospheric pollution associated with fossil fuel combustion is another environmental externality that adds more costs to South African society.

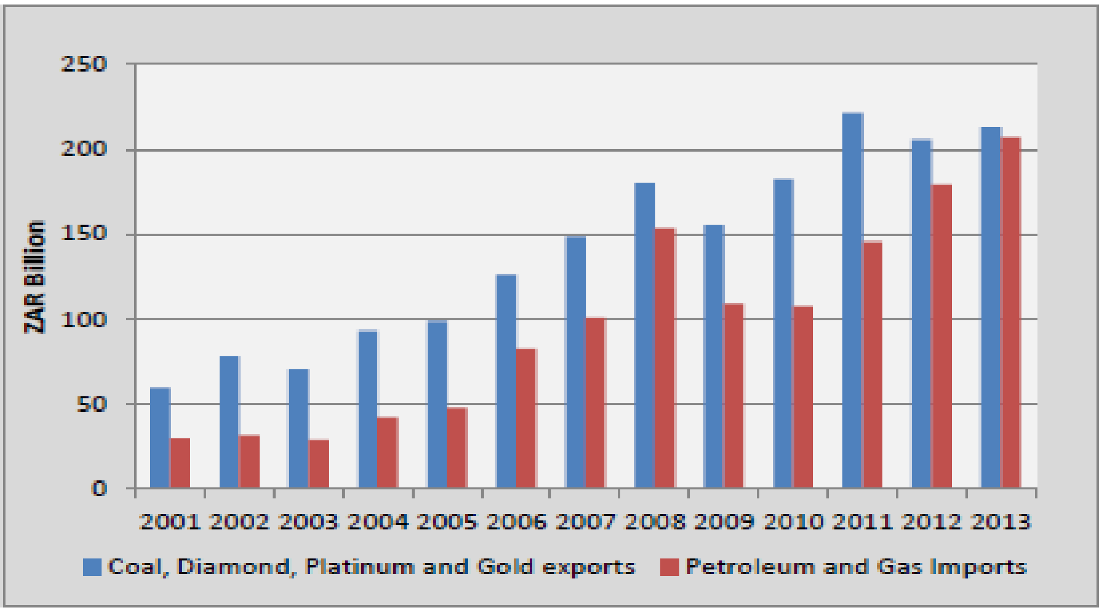

Figure 1.8: Comparison of Resource imports and exports (Department of Trade and Industry, 2015)

1.3.3. Sector's contribution to Green House Gas (GHG) emissions

The development of the transport industry, as indicated in section 1.2, was based largely on the wide use of fossil fuels. While the use of these fuels has contributed positively to economic progress in both developed and developing countries, this has come at a price. They produce carbon dioxide (CO_2) and related gases that cause global warming (International Transport Forum, 2010:5; Colvile et al., 2000). Between 2013 and 2040, energy related CO_2 emissions, according to the Maritime Executive (2018), are expected to grow by 40%. In terms of carbon emissions from fuel combustion, Vosper and Mercure

(2016) noted that South Africa is the world's 15th largest emitter of CO_2, contributing 1.2% of global emissions.

Fossil fuel use in road vehicles emits gases that adversely alter global climates – a global phenomenon that has drawn much attention among politicians, economists and environmental enthusiasts (World Mapper, 2019). Globally, the transportation sector is estimated to have contributed about 25% of CO_2 emissions, with the road segment having accounted for the most of these emissions – around 80% (Thambiran and Diab, 2011). In 2015, the International Energy Agency recorded 23% as the transport sector's contribution to global energy-related carbon dioxide (CO_2) emissions, stating that this sector remains the least diversified end-use sector with 93% dependence on oil (International Energy Agency, 2016).

The transport sector in South Africa has been one of the largest emitters of Green House Gases (GHG) which, according to Thambiran and Diab (2011), contributed about 9% of the country's emissions in 2009. By 2012, this number grew to 11% of national emissions (International Energy Agency, 2014). Road diesel and petrol vehicles contributed about 91.2% of total transport sector emissions in the 2010 DEA report (WWF, 2016). From the analysis of data provided in the Department of Environmental Affairs, 2000-2010 Green House Gas Inventory Report, the road segment accounted for more GHG emissions of around 92% of total sector as shown in Figure 1.9.

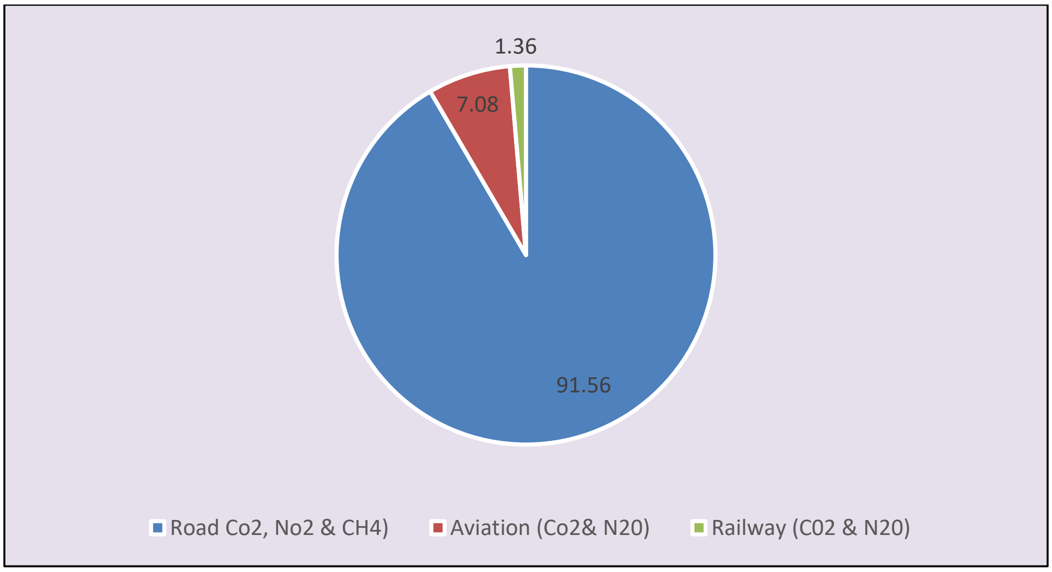

Figure 1.9: SA road transport contribution to GHGs (by author from data extracted from the Department of Environmental Affairs, 2000-2010)

Figure 1.9 excludes the marine sector. GHG emissions contribute to increased global temperatures and associated impacts. On its website, the World Wide Fund for Nature (WWF) (2018) listed and explained these impacts using Australia as a case study. These impacts are listed below:

- ❒ Ecosystems: stresses effects on ecosystems through temperature rises, water shortages, increased fire threats, drought, weed and pest invasions, intense storm damage and salt invasion.
- ❒ Species extinction: To survive, plants, animals and birds confronted with climate change have two options: move or adapt. With the speed of climate change we are experiencing already, it is often not possible for a species to adapt quickly enough to keep up with its changing environment and with the amount of habitat destruction, moving is becoming increasingly difficult.
- ❒ Food and farming: Changes to rainfall patterns, increasingly severe drought, heat waves that are more frequent, flooding and extreme weather make it more difficult for farmers to graze livestock and grow produce, reducing food availability and making it more expensive to buy.
- ❒ Water: Reduced rainfall and increasingly severe droughts may lead to water shortages.
- ❒ Coastal erosion: Rising sea levels and more frequent and intense storm surges, erosion of coastline and wearing away and inundating of community and residential properties.
- ❒ Health: Increasingly severe and frequent heat waves may lead to death and illness, especially among the elderly. Higher temperatures and humidity could also produce more mosquito-borne diseases.
- ❒ Damage to homes: Increasingly severe extreme weather events like bushfires, storms, floods, cyclones and coastal erosion, will see increased damage to homes, as well as costlier insurance premiums.
- ❒ Coral bleaching: Rising temperatures and acidity within oceans will contribute to extreme coral bleaching; in 2016 more than one-third of the Great Barrier Reef in Australia was destroyed (WWF, 2018).

From a study released in 2018 by Posada (2018) of the International Council on Clean Transportation (ICCT), Figure 1.10 compares the efficiency of South Africa's fleet with that of the European Union.

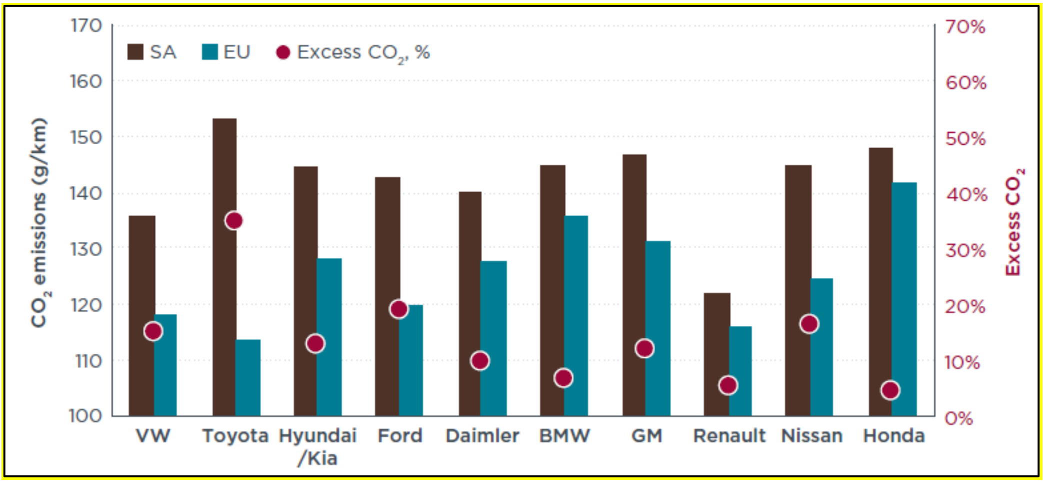

Figure 1.10: Efficiency of SA fleet versus the EU fleet (source: Posada, 2018: 10)

Posada's study revealed that a passenger vehicle powered by diesel emits about 14.4% more carbon dioxide per km than the average petrol powered vehicle. This study linked this to the common preference for special utility vehicles (SUVs) powered by diesel. On average, these vehicles may be the heaviest, but also perform better in terms of power output and torque. The study portrays Renault as a better performer compared to Toyota in terms of fleet average CO_2 emissions (Posada, 2018).

While there is global consensus on carbon dioxide (CO_2) emissions and climate change as a major contributor to the underlying environmental problems, the World Mapper (2019) notes that disagreements remain around the question of how to reduce the emissions. A closer look at these GHG emission impacts reveals they are not only an environmental issue, but also a socio-economic issue, which then explains the reasoning behind the many concentrated efforts undertaken at both international level and in South Africa to curb the emissions. Nonetheless, while GHG emissions are an important air pollution issue that requires such dedicated efforts, they are only part of the air pollution problem resulting from fossil fuel combustion inside conventional vehicle engines.

1.3.4. Sector's contribution to air pollution and associated human health problems

The use of fossil derived fuels contributes to the increased emission of pollutants that are harmful to human health (IGES, 2007). With fuel and air mixtures used as inputs to facilitate combustion inside an ICE, the output is a combination of emissions which include particulates and gases such as carbon dioxide, carbon monoxide, nitrous oxide and other toxics such as benzene, butadiene, formaldehyde and lead where leaded gasoline is still used (Faiz, Weaver and Walsh, 1996: 81). The emission of some of these gases pose various health risks ranging from increases in respiratory ailments like asthma and bronchitis, heightening of risk of life-threatening conditions like cancer and burdening of the health care system with substantial medical costs. In 2016, the World Bank reported air pollution as one of world's most serious contributing factors to premature deaths, which in 2013 alone cost the world economy around US$225 billion in lost workforce earnings (World Bank, 2016). In Sub-Saharan Africa and South Africa, this loss is equivalent to 0.61 % and 1% of the GDP, respectively. The most affected regions, according to the World Bank (2016), include those that are densely occupied and urbanising at a faster rate.

Altieri and Keen (2016) of the International Growth Center (IGC) have published findings on the cost of air pollution in South Africa. Refuting the 2012 findings by GBD which concluded that South Africa's deaths as a result of fine particulate matter (PM) amounted to 1 800, these writers claimed this was, in fact, over 27 000 deaths. While this number was not directly attributed to the transport sector, it must be noted that, this sector does emit particulate matter as indicated in Faiz, Weaver and Walsh (1996). Densely populated regions such as Cape Town, Durban, and the Johannesburg-Pretoria mega city area suffered the largest loss of life (Altieri and Keen, 2016). In 2012 the premature deaths, according to these writers, cost South Africa's economy around 6% of that year's gross domestic product.

Internal combustion is still the dominant technology in automobiles currently produced or imported for use in the South African roads. It must be noted that the future survival of this technology is being challenged vigorously as new inventions involving more fuel efficient non-ICE forms of vehicle powering systems are being developed in the major automotive manufacturing countries. These mark a transition towards the "greener economy" introduced in Chapter Two. Fossil fuel use as discussed in the preceding sections contribute to global warming, economic costs from purchase of imported fuels and medical bills, as well as a series of health problems associated with ICE tail pipe emissions. These have critical policy implications, especially in the context of the South African Government's Cleaner Fuels programme introduced in Chapter Five. There are indeed many causes of vehicular emissions which, according to Thambiran and Diab (2011), include the number of old vehicles utilised on South African roads. These are usually not fitted with pollution abatement technologies such as catalytic converters which assist in addressing incomplete combustion, especially during a cold start (Thambiran and Diab, 2011). In the case of diesel engines, the vehicles may not necessarily be fitted with suitable exhaust filters that are capable of capturing particulate matter, as was determined in a study in Durban by these authors. As a solution to these challenges, greening of the transport sector has therefore been seen as a solution to curbing negative impacts.

According to the US Union of Concerned Scientists (not dated), clean vehicle and fuel technologies provide the world with an affordable, available means of reducing transportation-related air pollution and climate change emissions. These include fuel-efficient vehicles that use less oil, cleaner fuels that produce fewer emissions, as well as electric cars and trucks that can entirely remove tailpipe emissions. Green transportation technologies adopted in the world are a direct response to the shortcomings of the traditional economic approaches to development. The following section provides brief background on the linkages between the traditional neoclassical economics and the emergence of the green economy revolution, under which transport greening belongs as a sub-component.

1.4. ECONOMY GREENING AS A RESPONSE TO THE DEFICIENCES OF CONVENTIONAL APPROACHES TO TRANSPORTATION

One of the nine key green economy focus areas that South Africa has prioritised is sustainable transport and infrastructure (Department of Environmental Affairs, 2019). Due to the close linkages between sustainable transportation and the concept of economy greening, this section provides a short background on the origin of, as well as challenges within, the green economy concept. These challenges, as argued in Chapter Seven, have implications for South Africa's transport greening path, both current and future.

The Council for Science and Industrial Research (CSIR) (2014:12) in South Africa traces the origin of the green economy concept from responses to the failure of neoclassical economics to effectively include the value of natural resources and environmental degradation in pricing and other market mechanisms. It is a paradigm brought onto the international agenda as a result of multiple challenges, where much focus, according to the CSIR, was placed on the ‘brown economy’ powered by fossil fuels. Some differ as stated below:

> The idea of a green economy is disguised socialism driven by an urge to regulate markets and constrain the innovativeness of capitalism. The green economy neglects equity and the right of development for developing countries (Hahn, 2013: 342).

As an attempt to define this paradigm, many definitions and descriptions have been assigned to the green economy concept, with the description adopted by the Government in South Africa implying:

> … the decoupling of resource use and environmental impacts from economic growth. It is characterised by substantially increased investment in green sectors, supported by enabling policy reforms. The Green Economy refers to two inter-linked developmental outcomes for the South African economy, that is: growing economic activity (which leads to investment, jobs and competitiveness) in the green industry sector, and a shift in the economy as a whole towards cleaner industries and sectors (Department of Environmental Affairs, 2019).

To achieve this, the Department of Environmental Affairs deems Government alone to be incapable of managing and funding this transition and hence advocates for combined efforts between civil society, the state and the industry. To CSIR (2014: 3), the ‘green economy is not a nascent sector, but rather an important economic framework that seeks to put into action the concept of sustainable development’. This suggests that South Africa should be seen as a mixed economy in handling issues related to economy greening. This thesis does not attempt to provide a detailed scrutiny of the meaning of ‘green’ or of ‘economy’. It nonetheless provides a short discussion that reveals several challenges associated with the term ‘green economy’ that relate to internal quandaries within the disciplines of environmental sciences and economics.

The definition of ‘greening’ from the Cambridge Dictionary (2019) has connotations of environmental protection: ‘the process of beginning to pay attention to the protection of the natural environment’. This therefore places the origin of this concept in environmental sciences. The same may be true for the term ‘sustainability’ which, according to Litman and Burwell (2006), tends to reflect a conservation ethic as opposed to a consumption ethic. Applied within the transport sector, the use of this term ‘discourages words that promote automotive traveling’ (Litman and Burwell, 2006: 240). These writers however noted that sustainability policies usually involve conflicts between different interests. Energy conservation as an example is likely to reduce the income and profits of companies that produce traditional types of energy such as fossil-based petrol and diesel.

While the concepts of greening and sustainability are closely related to environmental sciences, a number of worldviews exist within this discipline, including anthropocentrism and ecocentrism. These worldviews do not always agree on the drivers and goals for protecting the environment. Anthropocentrics, according to Bjerke and Kaltenborn (1999), argue that humans are at the centre of everything, with nature only deserving protection for its benefit to humans. They thus see nature in terms of the economic services it can provide to humans, hence limiting concern for natural degradation to the negative impact this could have on human beings (Rotering, 2010). It is further argued in Chapter Five of this thesis that the South African environmental provisions tend to position the country towards a more anthropocentric standpoint. The words ‘development’, ‘rights’, ‘ethics’, ‘sustainability’, ‘justice’ feature prominently in South African environmental legislation and these words, according to Kurian and Bartlet (2010), are truly anthropocentric in nature. While the history of western philosophy is dominated by this kind of anthropocentrism, Cochrane (2017) noted that the philosophy has come under considerable attack from many environmental ethicists. Ecocentrics, on the other hand, emphasises the intrinsic value of nature, arguing for nature’s own rights to exist irrespective of any useful value to humans (Beckmann, Kilbourne, van Dam and Pardo, 1997). These opposing arguments create a dilemma within the environmental protection movement.

A closer look at ‘economy’ highlights even more complications within those groups pursuing an economic development agenda. Mainstream economics, according to Rotering (2010: 20), is neither anthropocentric nor ecocentric, but rather capital-centric, favouring profits over humans and nature. This is one worldview – free enterprise or the neoclassical laissez-fair economic system, which is intertwined with capitalism (Economind, 2014). The CSIR (2014) criticises this system for resulting in a series of environmental challenges facing the world today. Some of these were presented in section 1.3. The free enterprise system is assumed efficient in the sense that for a given distribution of income, it can allocate available resources in the best possible way (Mohr, Fourie and Associates, 2015 and Allan, 1971). As a philosophy, it called for privatisation; improved management of the public sector; liberalisation of financial markets as well as reduced state spending. Built on the foundation laid by classical theorists (notably Adam Smith) of the 18th century, it is a model that promotes exclusion and self-regulation.

Busch, Jörgens and Tews (2004) noted that since the beginning of the 1990s, there has been policy diffusion evident in shifts from an interventionist policy approaches to voluntary-based policy tools. It is an assertion that governments should leave the individual alone unless there is a need to address specific injustices (WebFinance Inc, 2017). Adam Smith’s ‘invisible hand’ principle described in the *Wealth of Nations,* according to Ver Eecke (2013), infers that Government could never be impartial enough to manage a country’s economy successfully. Due to government deficiency in these qualities, Smith called for government non-intervention on economy related matters. Linked to this worldview are neoliberal economists who also criticise state intervention, calling for a policy model that seeks to transfer control of economic factors away from the public sector to the private sector. According to Cornish-Jenkins (2015), this theory was championed by Margaret Thatcher in the UK from 1979 and Ronald Reagan in the US from 1980.

In contrast, Keynesian economists call for state intervention. Much of justification for state intervention relates to the inability of the 19th century free market system to achieve broader social goals (Mohr et al., 2015: 277). This is in opposition to laissez-faire economics (Aitkins, 2009). While growth, according to Cato (2009), is needed, if it is brought at the expense of the planet and if it reduces the quality of life, it is a major problem.

In a different argument by Cook (2006), government intervention was aimed at complementing market forces. The lifestyles we expect in the 21st century, according to Cook, have contributed to massive losses in ecological biodiversity, emission of greenhouse gases that alter climate, hence triggering serious threats to the livelihood of generations to come. This calls for greening of the economy described in Pearce (1992*)* as follows:

> …green economy implies a rethink of the idea that we should design economic systems to meet the unconstrained desires of the homo economicas. The economic person is assumed to weigh up the costs and benefits to him or herself and to act to maximise the net benefits to the self (Pearce (1992: 3)*.*

This argument therefore assumes that people are greedy and to become less greedy, their behaviour needs to be modified. Most of the green economics debate therefore, according to Pearce (1992: 3-4), is about the size of this modification and the tools to achieve this. This calls for interventions aimed at constraining human greed and decoupling of economic growth from environmental impact. It is a concept, which, according to Bucher, Drake-Brockman, Kasterine and Sugathan (2014) implies that for the same unit increase in economic growth and human well-being, the same, or fewer natural resources are used, coupled with a reduced impact on the environment. While the definition of green economy varies from one organisation to another, what seems similar is that all approaches promote a move towards a new economic model based on ecologically compatible use of resources, economic efficiency and social justice (Bongardt and Schaltenberg, not dated). It is a new economy order which, although applauded internationally, also faces many criticisms.

Much of the discussion in this section has centred on the definitions and dilemmas around the concept of green economy, regarded in this section as a 'mother' to green/ sustainable transportation. Dilemmas within the green and the economy aspects can therefore not be ignored in the context of efforts to green South Africa's transportation sector. International experiences on government responses to green transportation as discussed further in subsection 1.5 and in Chapter Two (2), demonstrate a trend of demand and supply type of government interventions in the form of taxes, subsidies and the non-financial incentives. While South Africa does not have a well-established green transport industry, some efforts are evident in the discussion in the following sub-section.

1.5. STATUS QUO IN TRANSPORT GREENING TECHNOLOGIES

The early forms of green transportation were walking, riding of donkeys, riding of horses and the use of animal drawn wagons as portrayed on the website of South African History Online (2017). The questions of how far one could go with these modes of transport, and how much load these could carry, may receive various responses in terms of their greenness and sustainability in today's terms. Many green technologies have been implemented or are being investigated within the transport sector internationally. According to a report by the Academy of Science of South Africa (ASSAF, 2014), some of these technologies are in use or under investigation in South Africa, while others have the potential to be acquired through technology transfer mechanisms. The next form of green transportation technologies, still applicable today, involved efforts to improve the quality of fuels used in the engines hence reducing air pollution, as well as creating savings in fuel use through the adoption of fuel efficient vehicles discussed in the following sub-sections.

1.5.1. Fuel quality, fuel economy and vehicle efficiency targeting technologies

The early global responses to introduce three-way catalytic converters in new petrol powered vehicles were arguably the biggest exercise to address atmospheric emissions from end-of-pipe technology (Colvile et al., 2000). This, coupled with other measures in developed countries, such as improvement in fuel quality, played a significant role in reducing petrol and diesel induced end of pipe emissions, according to these authors. Following the discovery of adverse health impacts associated with the additive lead (Pb), the use of lead-free petrol commenced as early as 1960s according to McMichael and McMichael (2001). These writers noted that lead had been added to improve petrol's octane rating since the 1920s, hence leading to better performance.

In addressing tailpipe emissions, the early forms of transport greening measures focused on influencing technological advances. Vehicle manufacturers, according to Nesbit, Fergusson, Colsa, Ohlendorf, Jayes, Paquel and Schweitzer (2016) were forced to apply more advanced systems to control the internal combustion engine and other advanced after treatment equipment listed below:

- ❒ Diesel engine management: NOx emissions can be influenced simply by changing the timing of the fuel injection: late injection reduces the engine-out NOx emissions but at some cost in fuel efficiency and vice versa.
- ❒ Positive ignition-engined (PI or spark ignition): This is applicable mainly to petrol vehicles, where they get fitted with three-way catalytic converters.
- ❒ Exhaust gas recirculation (EGR): to manage NOx: EGR recirculates some of the

exhaust gas back into the engine. As a result, there is less oxygen available in the cylinder for combustion, leading to a lower combustion temperature and in turn to less NOx production.

- ❒ Lean NOx trap (LNT): The lean NOx trap is a catalytic converter that combines an oxidation catalyst, an adsorber to store NO_2 under lean-burn conditions, and a reduction catalyst.
- ❒ Selective catalytic reduction (SCR): SCR is an advanced and active control technology involving a catalytic converter that can reduce NOx to nitrogen.
- ❒ Diesel particulate filter (DPF): This technology involves a wall flow filter, which physically traps the solid particulate matter from the exhaust gas, including the solid carbon fraction and fine particles.
- ❒ Recent developments: Increasingly, SCR and LNT technologies are combined in high-spec diesel cars (particularly for the US market) to take advantage of the best operating characteristics of both. SCR and particulate filter technologies are also being combined to provide better emissions performance. These advanced options obviously will come at a cost (Nesbit et al.: 2016: 29-31).

In his presentation at the Automotive/Petroleum Industry Forum in Michigan, 2016, Ford's Chief Engineer, McCarthy (2016) argued that balancing CO_2 reduction requirements and increasing customer expectations, constrains the feasible solutions zone, hence requiring an integrated approach. As the fuel economy improves, customer fuel savings decrease with the willingness to pay for further incremental increases diminishing, while at the same time, product costs increase. There are therefore trade-offs, which this presenter argued, require actions on multiple fronts including vehicle, usage and fuel. In a study by Posada (2018) a number of areas to improve fuel economy are identified. They include in summarised form, technologies targeting the engine, the transmission, accessories, idling and road driving as portrayed in Figure 1.11.

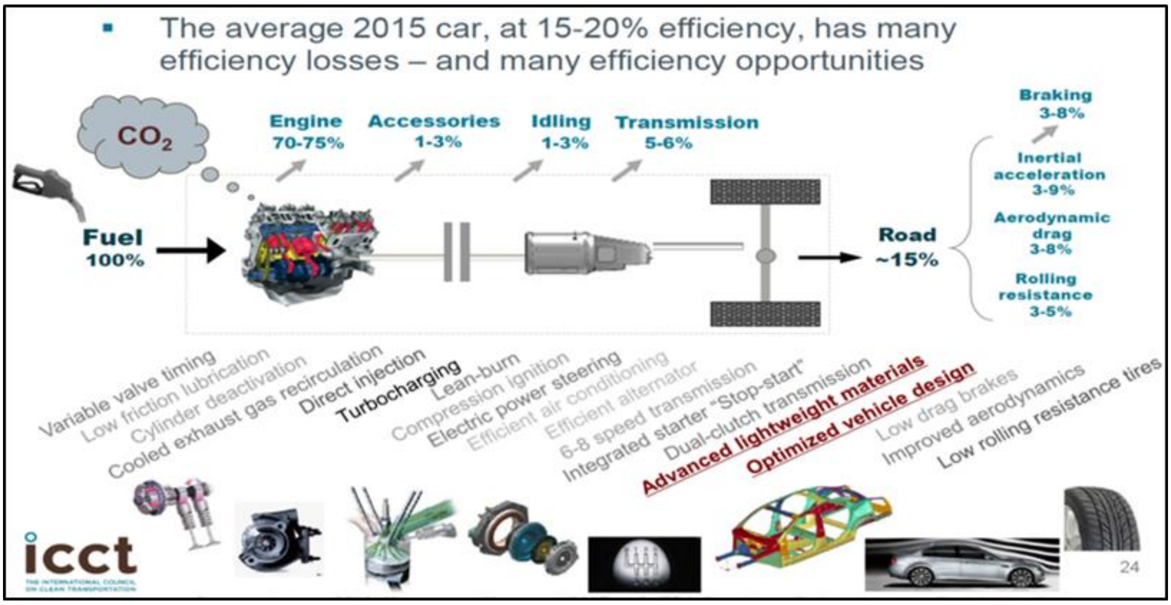

Figure 1.11. Efficiency loses and potential improvement areas in a 2015 ICE vehicle (Posada, 2018).

Road driving technologies further include a need to improve vehicle rolling resistance, aerodynamic drags and braking. Engine, idling, accessories and transmission improvement technologies include:

- Reduced body weight – Using a Ford sedan as an example, this presenter showed that body structures, chassis, and powertrain account for over 70% of the vehicle's weight, and hence provide the most significant opportunities for weight reduction. Typical body material includes use of ultra-high strength steels, aluminium as well as carbon fibre.
- Engine weight reduction, and incorporation of various innovative ideas, using the 1-litre engine as an example.
- Using advanced technologies such as direct injection systems, boosting systems, variable valve trains, power cylinder systems, cooled EGR, turbo chargers in diesel engines, engine control units.
- Transmission efficiency improvements also include clutches, gears, bearings, shafts along with technologies targeting reduced driveline losses.
- Thermal Management, Warmup, and Energy Recovery technologies, electrification as well as continued development of powertrain lubricants such as lower viscosity oils (McCarthy, 2016).

Some critics, notably Austin, Brimblecombe and Sturges (2002), had deemed the reduction in petrol and diesel engine vehicle emissions from the early interventions sufficient reason for further introduction of greener fuels. Ford's Chief Engineer McCarthy (2016), fourteen years later, also argued that from a Well-to-Wheels standpoint, maximum CO_2 reduction based on vehicle-only technology improvements will be limited. The use of low carbon fuels such as biomass, solar, wind, hydro and nuclear as well as use of alternative vehicles such as hybrids, battery electric, hydrogen fuel cells are another necessary ingredient in this battle for improved fuel economy.

1.5.2. Natural Gas Vehicle global experiences

By 2014, the world's compressed gas powered vehicles had reached a total of over 19 million vehicles, fuelled at 25 thousand fuelling stations (Seisler, 2014). This, according to Seisler, represented a 326% global growth rate when a figure of 4.6 million vehicles in 2006 is compared with that of 19.6 million vehicles in 2014. The top 10 leading countries, according to Seisler (2014) were: Iran at the top, followed by China, Pakistan, Argentina, Brazil, India, Italy, Columbia, Uzbekistan and Thailand. China experienced the fastest growth from 97 200 vehicles in 2006 to 3 million vehicles in 2014 (a 2986% increase). By October 2018, these figures had changed, with the total number of global Natural Gas Vehicles (NGVs) recorded at over 26 million vehicles as per the IANGV (2018) statistics, and China now leading the world in terms of vehicle numbers as shown in Figure 1.12. Based on the analysis of statistics by IANGV, as of 2018, Asia-Pacific and Latin America were leading the world in terms of NGV numbers at 70% and 21% each, respectively. With the exception of Italy which appeared on the top ten list, the European countries notably Germany, Russia and Georgia as well as the United States of America only appeared on the top twenty list in the IANGV (2018) ranking. In the European Union, only about 1.4 million gas vehicles are reported in the Natural & bio Gas Vehicle Association (NGVA) 2019 vehicle catalogue. This number includes both natural gas and liquefied gas vehicles.

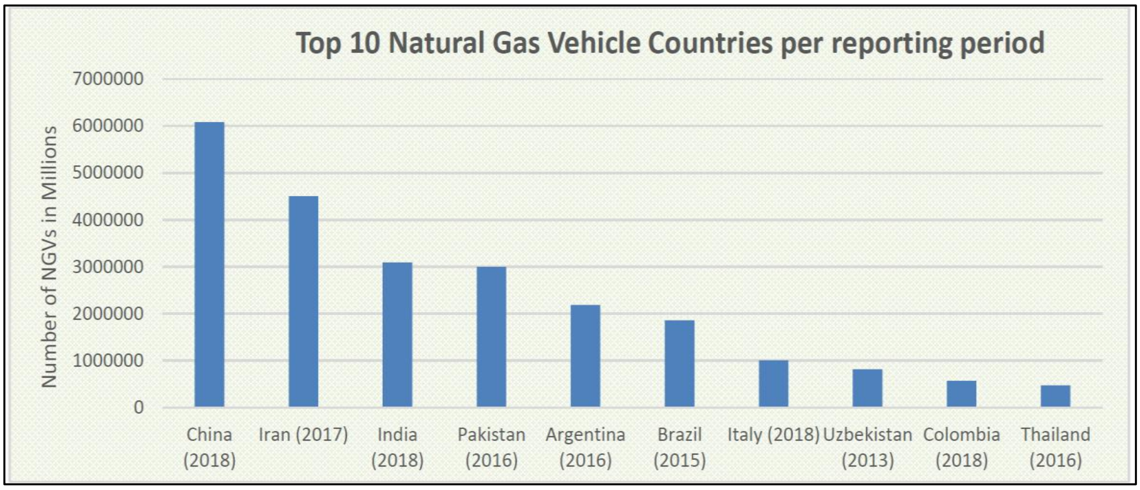

Figure 1.12: Natural Gas Vehicles (Source: produced by author from IANGV, 2018)

In South Africa, the industry has played a significant role in facilitating developments in NGV developments, especially in the province of Gauteng. Engineering News (2013) noted how the South African National Energy Research Institute (SANEDI) partnered with energy companies like CNG Holdings since 2009, to help establish CNG infrastructure for the automotive industry. In conjunction with the Industrial Development Corporation (IDC), to develop and implement this programme, Creamer (2017) noted that a number of fleet owners, including Megabus in the Free State province have partnered to develop gas infrastructure and related activities. Projects undertaken include the erection of infrastructure by Novo Energy to pilot the extraction and treatment of gas from a landfill site as well as the compression of such gas for delivery to distant customers (Stavers, 2011).

Fuelling infrastructure erected by both Novo Energy and CNG Holdings includes compression and dispensing stations in Edenvale, Benoni, Kew, Langlaagte, Dobsonville Soweto, Pretoria and Vanderbijlpark (CNG Holdings, 2015). The gas price in 2015 as per the author’s observation at some of the fuelling stations, ranged between R8.99/l and R9.99/l including VAT. This price has remained almost constant – in August 2018, the same price was noted in a gas filling station in Pretoria. This price excluded other charges such as the fuel levy and the road accident fund. The fuelling stations above can be found in two major metropolitans in Gauteng: Johannesburg and Ekurhuleni. The next challenge is to extend the network infrastructure to other metropolitan areas in the remaining eight provinces of South Africa. Private investors have disclosed their plans to roll out the conversion of a further 14 000 minibus-taxis in the next three to four years, erection of fuelling infrastructure, vehicle conversion workshops and the actual conversion of minibus-taxis (CNG Holdings, 2015). These conversions, according to CNG Holdings (2015), would require capital funds of up to R273 million.

A report by CNG Holdings (2015) included statistics with respect to the performance of a pilot project conducted with the Industrial Development Corporation to convert bus and minibus-taxi vehicles. This showed a 20.3% reduction in fuel running costs for a dual-fuel bus and a 20%-plus saving on minibus-taxis running on Compressed Natural Gas (CNG). Phase 1 of this pilot saw over 1000 taxis and vehicles being funded to convert to Natural Gas. Besides one of their flagship filling stations operating as a training and information centre, CNG Holdings also converted some of their filling stations to retrofit vehicles and dispense CNG. Each of the stations is able to service 500 taxis, trucks and buses a day at an average refuelling time of five minutes per vehicle, with the aim of increasing this to between 700 and 800 vehicles a day (CNG Holdings, 2015). To ensure that the municipalities are making a concerted effort to minimise their own carbon footprint, the City of Tshwane procured 40 CNG fuelled buses (Matlhale, 2015). These buses were added into the A Re Yeng Bus Rapid Transit (BRT) fleet as depicted in Figure 1.13.

Figure 1.13: City of Tshwane CNG bus (photo taken by author on 20/03/2019)

This is one of a typically good Bus Rapid Transit (BRT) systems, as it combines public transport and use of alternative greener fuel (CNG). As early as 2014, the City of Johannesburg, according to the Sandton Chronicle (2014), had commenced piloting the conversion of its bus fleet to run on a mixture of compressed natural gas and diesel. About 30 diesel powered buses were later converted with the assistance of Italy's Ecomotive Solutions Company and engine calibration specialist (Mcilhone, 2015). The city also made a commitment to procure 70 more buses. Creamer (2017) reported Megabus's initiative to procure 10 Euro 6 Scania buses, to be fuelled on methane gas supplied by a Free State province-based company, Tetra4. These buses were to be trialled for the next five years at the company's Free State operations. This has been brought about through the involvement of South Africa's State-owned Industrial Development Corporation (IDC), which according to Creamer (2017), approved R218-million in loan finance to support the development of a natural gas resource in the Free State province.

1.5.3. Liquid biofuel powered vehicles

Marcacci (2012) noted that biofuels go as far back as 1908, when Henry Ford ran the Model T on bioethanol. The United Nations Conference on Trade and Development (UNCTAD) (2014) noted that prior to the 2008 economic crisis (which resulted in a sharp rise in oil prices), the world had already commenced placing emphasis on innovative ways to add value to agriculture in a way that promised to produce greener jobs. A new focus was placed on biofuels as a renewable source of energy, with this market also spreading across the globe (UNCTAD, 2014). World production experienced a sharp increase in the period 2005 to 2013. In an article by Marcacci (2012), this market was however set to increase from over $80 billion in 2011 to over $184 billion in 2021. Faster production increases were then expected between 2017 and 2021. In 2017, van Dyk, Su, McMillan and Saddler (2019) noted that the world produced about 140 billion litres of biofuels, hence supplying a little over 4% of global transportation energy demand.

The International Energy Agency (2014) noted that the use of liquid biofuels in the transport sector experienced the largest growth among all other bioenergy sectors, reaching an annual growth rate of 5.4% in 1990-2000 and even a higher annual rate of 19.2% over the period 2000-2010. Africa and Asia, according to the International Energy Agency (2019), account for more than half of global bioenergy demand. In a study that reviewed the socio-economic implications of second generation biofuels in Southern Africa, Charis, Danha and Muzenda (2018) argued that biofuel demand is increasing around the globe, with the second generation biofuels envisaged to gain a larger market share than first generation fuels. This is due to their vast availability, limited interference with food security and ecological benefits. A UK based biofuel organisation also noted that, like fossil fuel production, the global production of biofuel will occur in areas that grow specific biofuel crops as depicted in Table 1.1.

Table 1.1: Biofuel feedstock (Biofuel.org.uk, 2010)

Region	**Fuel Production (litres)**	**Major Feedstock**
EU	10 billion	Corn or Soybean
America (North)	40 billion	Corn or Soybean
America (South)	25 billion	Corn or Sugar cane
Africa (including Middle East)	2 billion	Animal dung or Jatropha
Australia/ Asia	4 billion	Palm oil
TOTAL	**~81 billion**	

Despite the increasing role that bioenergy plays at global levels, the International Energy Agency (2018) pointed out that there has been no significant growth of the biofuels sector in South Africa. Biofuel.org.uk (2010) mapped global distribution of biofuels as portrayed in Figure 1.14. In this map, North and South America appeared as market leaders, followed by the EU, Asia and finally Africa. Even if the biofuels industry doubles the 2011 production levels, this would still represent only 7% of the total transportation fuel market, according to Marcacci (2012). The 7% figure was very ambitious, given the 4% that van Dyk et al. (2019) arrived at in 2017.

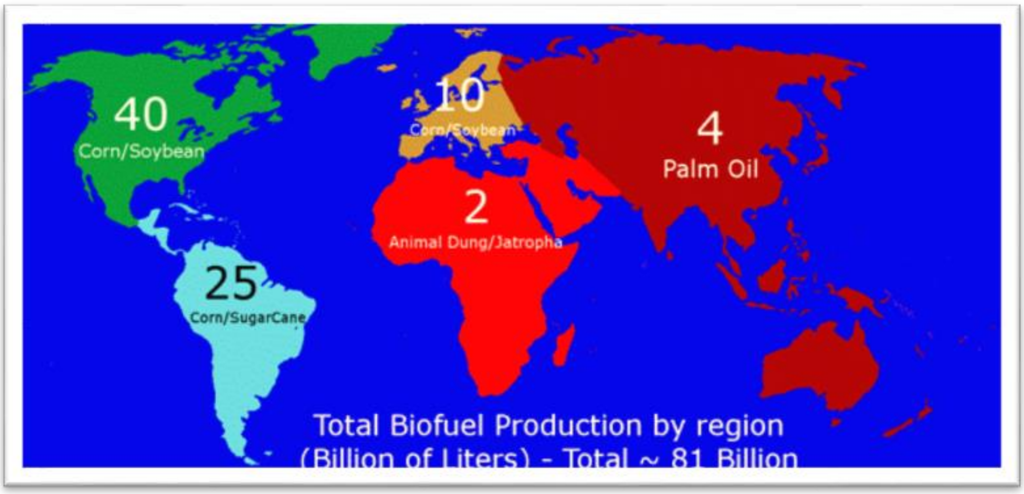

Figure 1.14. Major biofuel producers by region (Biofuel.org.uk, 2010)

Chemically and functionally, biofuels differ from petroleum-derived fuels and as such, they are not readily useable in existing petroleum processing and distribution infrastructure (Van Dyk et al., 2019). Compared to petroleum fuels, they are marginally more expensive, however they offer carbon emission reductions of 30–50% according to Stafford, Lotter, von Maltitz and Brent (2019). For the transport industry, there is more potential in what Van Dyk et al. (2019) referred to as "drop-in" biofuels. They define these fuels as "liquid bio-hydrocarbons that are functionally equivalent to petroleum fuels and are fully compatible with existing petroleum infrastructure" (Van Dyk et al., 2019: 01), able to achieve major emission reduction. The technology (Fischer-Tropsch synthesis) already exists to produce drop-in biofuels, with the key challenge being the cost, sustainability and availability of the lipid/oleochemical feedstock. Fischer-Tropsch can use syngas derived from any source including biomass and as noted in Van Dyk et al. (2019), South Africa, Malaysia and Qatar already use this technology at industrial scale through companies like Sasol and Shell. This however requires proper treatment and conditioning of syngas, something that has proved very difficult for biomass compared to coal and natural gas currently used in transport (Van Dyk et al., 2019).

1.5.4. Bioethanol production

The European Biofuels Technology Platform (2015) noted that the USA as well as Brazil account for most of the global production of bioethanol. The review of work done by the OECD/FAO (2015) portrays China as the fourth biggest consumer as well as producer of bioethanol, following the EU, USA and Brazil. The USDA Foreign Agricultural Service (2018) notes that biofuels forms part of China's long-run strategy targeting resource conservation, air quality improvement and reduction of too much dependence on imported fossil fuels. Based on the comparison of production and consumption statistics shown in Figure 1.15, most bioethanol volumes produced in these countries are destined for the local markets.

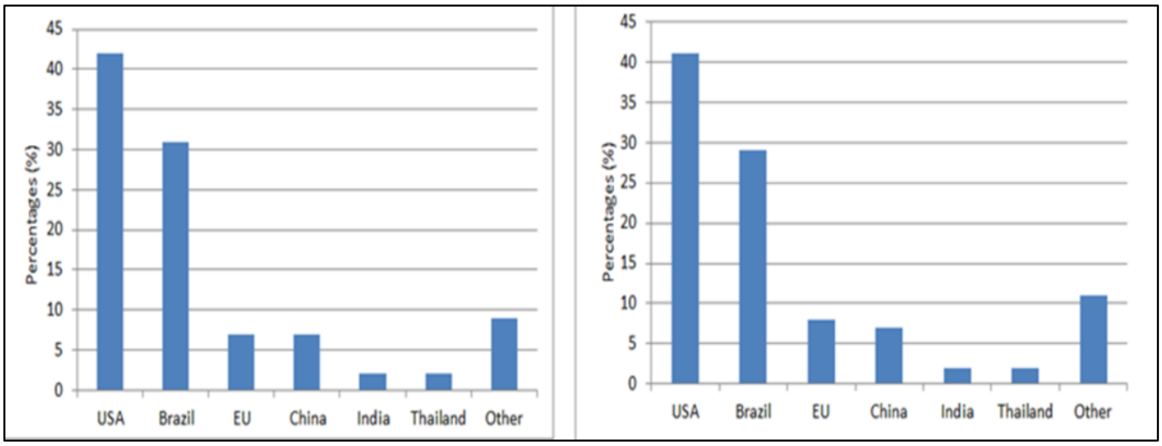

Figure 1.15: World bioethanol production (left) and consumption (right) in 2024 (OECD/FAO, 2015)

OECD/FAO (2015) noted that as fuel, ethanol has been around for some time and has played a vital role as an additive in fuels for many years. Produced largely from sugarcane, and used for fuel, Brazil's total domestic demand for ethanol in 2018 was estimated at 28.72 billion litres (USDA Foreign Agricultural Services, 2018). The International Renewable Energy Agency (IRENA, 2019) regarded sugarcane as a crop with considerable potential for African countries, noting that this feedstock has been under-utilised for biofuel production. IRENA (2019) identified seven southern African countries (Eswatini, Malawi, Mozambique, South Africa, United Republic of Tanzania, Zambia and Zimbabwe), with sufficient land to produce over 35 million tonnes of sugarcane. These countries however produce only about 4.1 million litres of ethanol from sugarcane (FAO, 2018). Some of these countries, according to the European Biofuels Technology Platform (2015), are nonetheless exploring opportunities for bioethanol production using sugarcane.

A collaborative study between South Africa's Departments of Trade and Industry and Science and Innovation in 2019, revealed undesirable findings on sugarcane potential as feedstock for bioethanol production. In a report compiled for these departments by the UCT Energy Centre (2020), bioethanol production costs therefore translate to about 1.7 – 2.3 times the Basic Fuel Price (BFP), which the country uses as reference price to financially support potential biofuel manufacturers. The conclusion drawn from this study is that ethanol first generation is not attractive as base blending stock but potentially of interest relative to imported refined products. According to the Sugar Industry Draft Master Plan (2020-2030), this industry currently employs an estimated 65 000 people directly, and 270 000 indirectly. The sugar annual production has however declined by nearly 25%, from 2.75 million to 2.1 million tons per annum, over the past 20 years. The number of sugarcane farmers has also declined by 60% during this period, and sugar industry related jobs are estimated to have reduced by 45% (Sugar Industry Draft Master Plan, 2020-2030).

1.5.5. Biodiesel production

While biodiesel use in traditional engines still requires some form of modification, it does not require as extensive modification as bioethanol engines (Pojani and Stead, 2015 and Faiz et al. 1996). Both fuels can only be used in relatively low blends, with ethanol at maximum blend of 15% and biodiesel at maximum blend of 20% (Van Dyk et al., 2019). They are, according to Van Dyk et al. (2019), still not fully compatible with existing combustion engines or the overall liquid transportation fuel refining and distribution network. Unlike in Europe, stricter regulations on diesel emissions in the US delayed the production of biodiesel (Biofuel.org.uk, 2010).

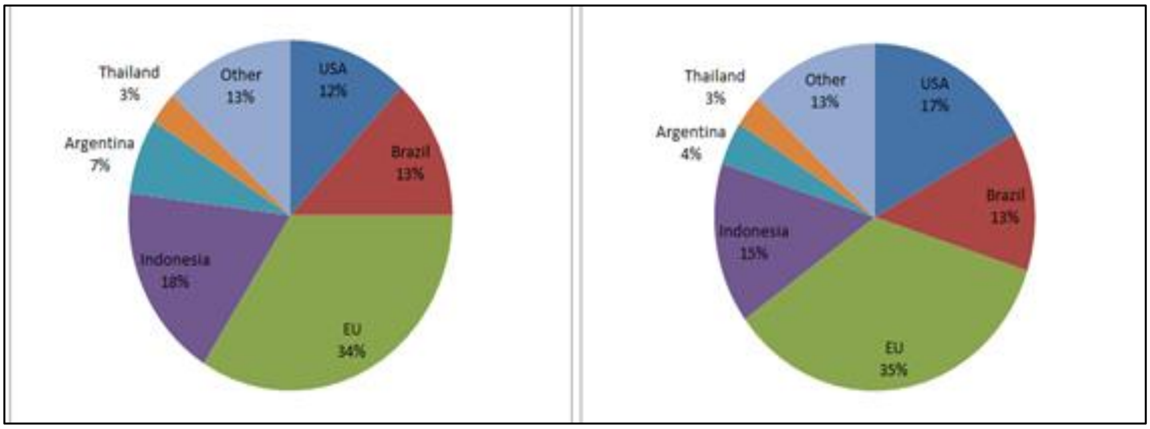

Figure 1.16: World biodiesel production (left) and consumption (right) in 2024 (OECD/FAO, 2015)

In South Africa, the Department of Energy (2014) issued four biodiesel manufacturing licenses, for the production of 970 million litres of biodiesel. However no plants have been constructed to produce these fuels at commercial scale. This could be associated with the financial non-viability of biofuel projects at the then prevailing feedstock and crude oil prices (Department of Energy, 2014). Biodiesel in South Africa is only produced on a small scale, using largely waste vegetable (cooking) oil. Concerns for food security, according to Charis et al. (2018), have driven Southern African countries to avoid feedstock that compete with food. As such, these countries promote the use of second and third generation feedstock from non-food sources. As noted in the Engineering News (2016), *Solaris,* a tobacco crop in the Limpopo province of South Africa, was used to manufacture the first aviation biofuel used to fly a Boeing from Johannesburg to Cape Town as depicted in Figure 1.17.

In concluding this sub-section, biofuels, especially drop-in biofuels, according to Van Dyk et al. (2019), are capable of making a key contribution to addressing climate change. In South Africa, the Government identified biofuels for their potential role not only in curbing the emission of greenhouse gases, but also for their potential ability to assist with other pressing socio-economic imperatives, including economic development and creation of employment opportunities in the agricultural sector (Department of Energy, 2014).

Figure 1.17: South Africa's first jet biofuel flight in 2016 (30% Solaris tobacco plant fuel blend) (Engineering News, 15/07/2016)

Biofuels may be more useful for non-urban transport and long distance areas where electrification and the adoption of electric vehicles currently proves to be a challenge. As such, sectors such as long distance trucking (also aviation and marine sectors), are likely to create a market for low carbon intensity, drop-in biofuels, as argued in Van Dyk et al. (2019). With the roll-out of biofuels currently presenting the world's countries with many challenges including higher costs of production (Stafford et al., 2019), these fuels can therefore not be regarded as a 'silver bullet' to deal with transportation problems in all regions of the world. In urban areas, factors such as air pollution, congestion and shared-economy, all contribute to a need to develop transport industry electrification systems as discussed in the following sub-section.

1.5.6. Electric powered vehicles (EVs)

In its 2013 Global Electric Vehicle (EV) Outlook, the International Energy Agency (2013: 23) provided a detailed chronology on how the electric vehicle industry has evolved over the past two centuries. In the period between 1801 and 1850, Scotland and the USA invented the initial EVs. The *first age* (1851-1900), the *boom and bust age* (1901-1950), the *second age* (1951-2000) right through to the *third age* (2001- to date) followed. Around the 1930s, Hybrid Electric Vehicles and Electric Vehicles disappeared, leading to the failure of all private enterprises set up to deliver on this new technology (Chan, 2013). The main reasons for EV failure related to the following events that occurred following the launch of this technology:

- *Limited range* – most EVs provided 60–100 miles compared to 300 or more miles from gasoline-powered vehicles;
- *Long charging time* – eight or more hours;
- *High cost* (40% more expensive than gasoline cars) and limited cargo space in many of the EVs available;
- *Cheap gasoline* – the operating cost (fuel cost) of cars is insignificant in

comparison to the investment that an EV owner makes in buying an EV;

- *Consumer responses* – consumers believed that large sports utility vehicles (SUVs) and pickup trucks were safer to drive and convenient for many other functions, such as towing. Therefore, consumers preferred large SUVs over smaller efficient vehicles (partly due to the low gasoline prices);
- *Large investments on Research and Development (R&D) by car companies, with less returns on investments* – automobile manufacturers spent billions of dollars in research, development, and deployment of EVs, but the market did not respond very well. They lost money, selling EVs and maintenance and servicing of EVs were additional burdens on the car dealerships. Liability was a major concern, though there was no evidence that EVs were less safe than gasoline vehicles; and
- *Gas companies* – EVs were seen as a threat to gas companies and the oil industry. Lobbying by the car and gasoline companies of the federal government and the California government to drop the mandate was one of the key factors leading to the disappearance of EVs in the 1990s (Mi and Masrur, 2017: 6-7).

1.5.7. Renewed interest in EVs

In 1997, a Toyota Prius hybrid was introduced (Mia et al., 2011). This hybrid, as well as the Honda Insight and Civic, were made available in America as early as the year 2000. Following the 2008 fuel price escalations, Nissan launched its Battery Electric Vehicle (BEV) – the LEAF in 2010. When talking about green transportation today, EVs are at the top of the world agenda, with commitments in some countries for a complete phase-in of EVs by 2050 and a phase-out of fossil fuel powered vehicles. In 2016, Bloomberg's New Energy Finance reported that 35% of global new vehicle sales will be electric by 2040 (MacDonald, 2016). An account of this new development is well recorded in literature as shown in the quotation below. Here it is noted how specific countries and regions have announced plans to phase out the usage of fossil fuel vehicles hence promoting a shift to e-mobility:

> … Norway plans to phase out fossil fuel vehicles in 2025, Ireland, Netherlands and Slovenia in 2030, Scotland in 2032, California, France, Sri Lanka and the United Kingdom in 2040. Most of the countries plan to ban sales of internal combustion engines. India has previously made statements regarding a possible phase-out by 2030 but the most recent EV roadmap does not include any phase-out targets. Other countries have set targets for absolute number or overall share of electric vehicles by a certain year. 2020 is a major target year, with Spain aiming for 2.5 million electric vehicles, Germany and India aiming for 1 million, Portugal targeting 750,000 and South Korea aiming for 200,000 electric cars. Country targets for 2030 include Finland's goal of 250,000 electric vehicles, Malaysia aiming for 100,000 electric cars, and South Africa's targeting a 20% share of electric cars. Norway is a leading country in terms of e-mobility thanks to financial incentives (Partnership on Sustainable Low Carbon Transport*,* 2018: 3).

As a way of promoting the uptake of EVs, the leading markets adopted a number of incentives discussed in detail in Chapter Two. In its 2015 Global EV Outlook, the International Energy Agency (IEA) (2015) presented data from Electric Vehicle Initiatives of its 16 member governments. This indicates a dramatic growth in the global stock of electric vehicles though an increase in the deployment of charging infrastructure as well as a reduction in battery costs. In the 2018 version of this IEA publication, China is described as the world's market leader in EVs, with around 580 000 EV cars sold in 2017. In the 2018

EV Global Outlook, the International Energy Agency (2018) noted that China alone represented almost half of the global market for EVs, with Norway labelled as the 'absolute leader in market share' as depicted in Figure 1.18.

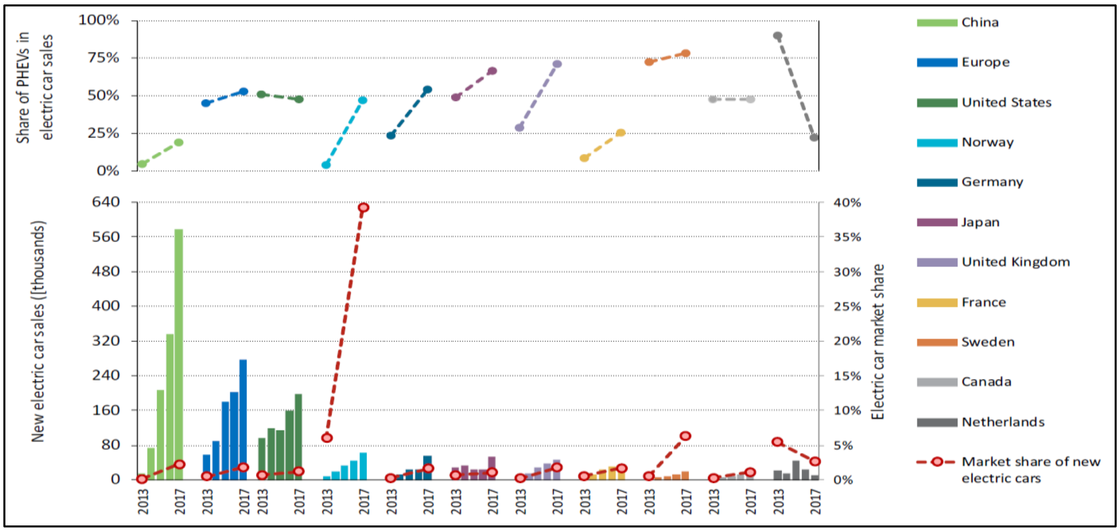

Figure 1.18: Top 10 Leading EV Countries in terms of Sales and Market Share (source: IEA, 2018)

The question that remains, however, is why the world is putting so much emphasis on EVs now if these technologies failed once as discussed in the preceding paragraphs. What is being done differently from what was done before? Even today, most of the issues that led to EV failure are still a reality in South Africa, and this could be the same with other countries that are making attempts to resuscitate this technology.

1.5.8. South Africa's role in EV development

Investigations into EVs in South Africa, according to the ERC (2013), commenced some 48 years ago at the Council for Science and Industrial Research (CSIR). The ZEBRA battery and lithium-ion cathode materials formed part of the first products investigated and produced. Besides CSIR, the National Energy Council, Eskom and the South African National Energy Research Institute (SANERI), the Department of Science and Technology, conducted various research initiatives, some of which culminated in the five-seater electric car well known in South Africa as the Joule, depicted in Figure 1.19. This vehicle, partly funded by the Industrial Development Corporation (IDC) and developed by Optimal Energy, did not make it to the market due to various reasons such as lack of suitable partners and funding to facilitate mass production and migrating the prototype to the commercial stage (Alfreds, 2012). Lack of recharging infrastructure is often cited as one of the reasons for failure of this project. Others point to the lack of clarity regarding the roles of public versus private stakeholders to the high commercial risk associated with the project. Competition with high-end investments from commercial companies around the world, such as Nissan, General Motors and Toyota, led to this ultimately sealing the Joule's fate (ERC, 2013). These OEMs have more capacity than the new players in producing electric vehicles.

Figure 1.19: South Africa's Joule Vehicle at Paris/ Geneva Motor Show (left) by Optimal Energy (2008/2010); Joule marketing fleet (right) by Diana (2011) and Joule parked at Nelson Mandela University (bottom) (by author, 2016)

Regarding the latest developments in EV roll-out in South Africa, a steady but noticeable addition of alternative fuel vehicles has been noted recently. This includes the introduction of hybrids such as the Toyota Prius, BMW i8 as well as the fully electric machines such as the Nissan Leaf, BMW i3, Mercedes EQC 400 4Matic, and the Jaquar i-Pace. Sale in South Africa of these vehicles is small, with Nissan Leaf reporting only 83 units in 2015 (as per confirmation from a Nissan South Africa representative in 2016). BMW reported sales of up to 419 units of both the i3 and the i8 Models (Venter, 2017). The sale of petrol and diesel hybrids totalled 144 units in 2018 compared to 303 units sold in 2017 (Mahomedy, 2019). The sale of electric vehicles, on the other hand, totalled 58 units in 2018, compared to 68 units sold in 2017. Parmar (2019) recorded a national total of 4827 HEVs, 535 PHEVs and 472 BEVs in June 2019. Electric vehicles in South Africa, according to the National Association of Automotive Manufacturers of South Africa (NAAMSA), account for around 1.5% to 2% of the global market (Mahomedy, 2019).

These electric and hybrid units have been sold to private individuals and companies as well as to organs of state. The latter include the National Department of Environmental Affairs (10 units), the City of Tshwane (over 10 units), Eskom (over 10 units as part of a lease-agreement with Nissan to conduct research over the performance of EVs) and Department of Trade and Industry (1 unit donated by UNIDO). The Council for Science and Industrial Research bought about 10 EVs, which included four BMWi3s, and six Nissan Leafs, incorporating them into their vehicle fleet for use by the employees. At a cost of R128 million, the City of Cape Town procured 11 electric buses for the MyCiTi project from Chinese electric bus company BYD (Mahomedy, 2019).

Electric vehicle numbers in South Africa are still small; however, those procured by organs of state provide some signal of the Government's commitment to a transition to this cleaner transportation technology. Besides the sale of largely imported EVs in the country as indicated in Mahomedy (2019), there are examples of innovations from local entrepreneurs including the work of Grid Cars who manufacture and install electric charging infrastructure, and others. Other interventions include the conversion of petrol/ diesel vehicles to electric drive trains such as work of Freedom Won (2015) and uYilo programme (Autolive, 2015) as depicted in Figure 1.20. These local innovations are beginning to raise many policy questions, including those related to homologation requirements with respect to the road worthiness and safety of these converted vehicles, as discussed in Chapter Five.

Figure 1.20: South Africa's local conversions of EVs (left - uYilo programme, right - Freedom Won) (source: Autolive, 2015 and Freedom Won, 2015)

Regarding lack / insufficient deployment of EVs in South Africa, reasons often cited by the industry community and the public include high CAPEX costs as a result of high import tariffs (Mahomedy, 2019 and ERC, 2013). In the case of fully electric vehicles, the limited range currently available compared to the ICE powered vehicles is another challenge. Many battery electric vehicles developed and operational in the OEM countries have not yet arrived in South Africa, e.g. the Tesla models. With increasing diversification of production lines in the EV manufacturing countries, continued research in the EV industry and changes in regulatory environment, more and more electric vehicles may find their way into the South African market in the near future. Battery electric vehicles are, however, not the only greener vehicle technology, as hydrogen fuel cells discussed in the following sub-section provide another technology choice.

1.5.9. Hydrogen fuel cell transportation

Fuel cell technology, according to market study findings released by Research and Markets in 2017, have applications in various mobility technologies including motorcars, trucks, buses, forklifts, motorcycles, bicycles, airplanes, boats, submarines, and trams (Wood, 2015). The study concluded that cumulatively, over 22.2 million hydrogen fuel cell vehicles will be sold or leased worldwide by 2032, hence generating collective revenues of up to $1.1 trillion for the auto industry by this period. In a report compiled on behalf of the US National Department of Energy, Curtin and Gangi (2015) added stationary power and portable applications as alternative markets for fuel cells. This report further provides megawatt size of fuel cells per sector shipped since 2008 to 2015.

While fuel cell use in stationery applications has so far been larger than in other areas, use in the transport sector seems to be on the rise, especially in 2015 as indicated in Figure 1.21. This sudden rise could be due to light duty vehicles, which according to Wood (2015), entered the market only in 2015 in the North America, Japan and Europe.

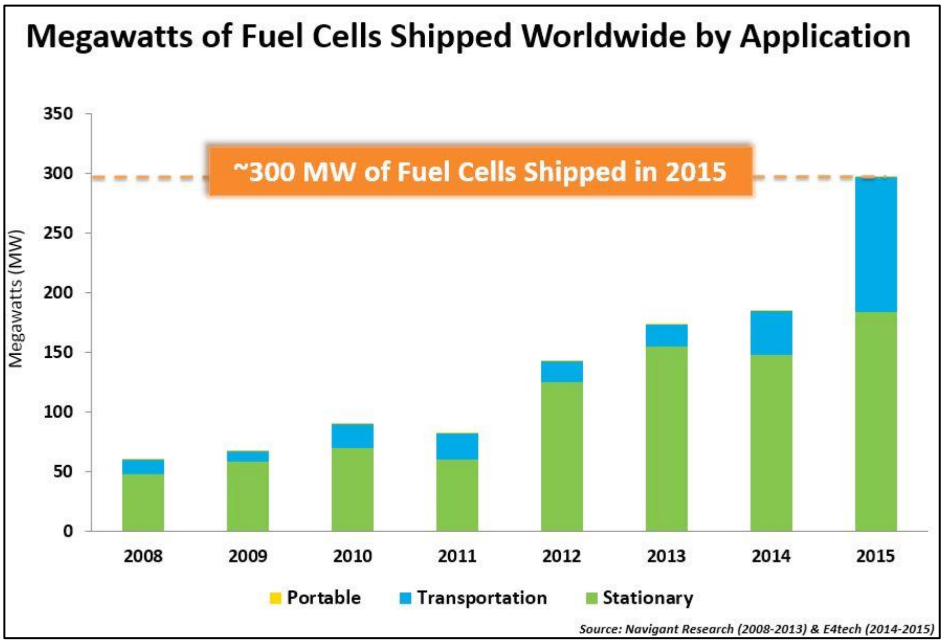

Figure 1.21: Fuel cell shipment (Wood, 2015)

Wood (2015) alluded to the new market report released by *Research and Markets* in June 2017, which states that while the fuel cell market is in its infancy, it has potential for growth. According to this report, there were over 6000 hydrogen fuel cell vehicles worldwide sold to date from 2013 when this industry first made inroads. Over 50% of these have been sold in the US (mainly California), about 38% in Japan and the rest in the EU (Information Trends, 2018). On the manufacturer side, Toyota delivered more than 77% of all hydrogen fuel cell cars ever made with the rest by Honda and Hyundai, respectively.

In the US, the state according to Curtin and Gangi (2015) supports research and development of fuel cell and hydrogen activities, by making necessary incentives available to academic and private sector institutions. As such, the interest that Government has shown ensured the development of several support policy frameworks aimed at encouraging the introduction of fuel cells and fuelling infrastructure. In South Africa, Platinum Group Metals (PGMs) are used in two major applications, jewellery and catalytic convertors. These represent over 90% of all demand for the metals, and according to the IDC and **the dti** (2017), if the catalytic convertor is not replaced with fuel cells based transport applications, about half of all demand for PGMs will be lost.

Anglo American Platinum in South Africa views hydrogen fuel cell electric vehicles as an important innovation to reduce tail pipe emissions from internal combustion engines (Anglo American Platinum, 2017). To meet emissions targets, according to this company, vehicular electrification will have to occur. Anglo America has presence in South Africa, mining platinum, most of which this country exports in un-beneficiated form. The company has demonstrated its passion and commitment to fuel cells at the 17th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP17) in Durban-South Africa. Together with Ballard Power Systems Inc., they unveiled a 150KW fuel cell demo system, highlighting the company's commitment to further fuel cell systems rollout to its mining operations (Ballard Power Systems Inc., 2011). In 2012, Anglo American Platinum also launched the fuel cell powered underground locomotive in Rustenburg. Another local company, Impala Platinum (Implants), in collaboration with South Africa's research institution (HySA), linked to the Department of Science and Technology, developed a fuel cell forklift prototype. They launched this prototype and hydrogen refuelling station at the Base Metals Refinery dispatch section, in 2016. It is Implant's longer-term strategic investment project, initiated in partnership with the Department of Trade and Industry, the Gauteng Industrial Development Zone, with support from Ekurhuleni Metro (Robertson, 2017). While the fuel cell market is still in its infancy in South Africa, recent developments indicate a growing appetite for the technology. In order to promote further deployment of this technology, van de Groenendaal (2016) called for some kind of cooperation between Government and private companies to install support infrastructure.

The fuel cell industry is indeed a nascent industry not only in South Africa, but also at global levels. As such, if South Africa is to achieve real progress in promoting fuel technology uptake in transportation, as well as the greener transportation industry as a whole, it has to collaborate with other leading countries. Given the multitude of transport greening technologies and initiatives available internationally, South Africa's decisions on the best options, should however be guided by objective research, capable of assisting this country's efforts towards meeting its socio-economic and environmental objectives. Research is indeed happening in South Africa as introduced in the next sub-section. This sub-section however, provides a very brief summary of such research, where the main aim is to highlight the gaps, introducing the problem statement, which drove the author's desire to initiate the research presented in this thesis.

1.5.10. Brief introduction on transport greening research in South Africa

Since the advent of democracy in South Africa, much literature in the form of academic, policy and technical papers according to Bickford (2013) has been produced around the topics of public transport and mobility. Mitchel and Walters (2011) evaluated the efficacy of transport policy making and implementation in the primary roads and commuter bus transport sectors during the periods 1986-1996 and 1990-2000. Limited writing explicitly targets sustainability (Bickford, 2013). Examples of these limited studies include the tax policy study conducted by Vosper and Mercure (2016) on the effectiveness of the CO_2 levy in changing the behaviour of private vehicle consumers. Research by ERC (2013) cited lack of coordination and integration across government departments as one of the fundamental impediments to green transport sector development in South Africa. Walters (2014) also highlighted the lack of integration, working in silos, the complexity and lack of clarity around the relationship between the three spheres of Government regarding transport planning, as major threats to the implementation of integrated and sustainable public transport. The lack of integration was also highlighted in Moodley, Chetty, Reddy and Simmer (2011) and Holtzhausen and Abrahamson (2011) in their examination of the metropolitan cities of eThekwini and Cape Town, respectively. Government representatives, however, often argue against such criticisms, saying Government is well integrated and working together. This was observed in the response of panellists in the Second National Biogas Conference in 2015 (Department of Energy and SABIA, 2015: 32).

In 2013, through the Green Fund Project, the Development Bank of Southern Africa (DBSA) awarded grants to 16 research and policy development projects (Suleman, Gaylard, Tshaka and Snyman, 2015). One such project with direct relevance to green transportation was facilitated by the South African Cities Network and was entitled ‘Accelerating the transition to green transport: South African cities green transport programme’. This research did provide a review of green transport policy environment, but the review lacked depth and did little more than provide a summary of gas, biofuels and electric vehicles. It made relevant policy recommendations, but again these were shallow and generic and were biased towards municipal based transport greening initiatives. While this research did not provide an exhaustive list of studies conducted in the context of transportation in South Africa, it did note the generic studies as well as those relevant to greener transportation. A study which attempted to cover a wide range of issues relating to transport sector greening was conducted by the national Department of Trade and Industry (**the dti**) (2016). The findings revealed that most transport related provisions in the country’s legislative framework are concentrated around conventional systems. Like other studies, **the dti** study is limited in scope providing an analysis of policies, regulations, legislative framework, taxation and subsidies for electric vehicles, biofuels, compressed natural gas and hydrogen fuel cells. It excluded transport greening areas such as cleaner fuels, fuel economy, modal shift and non-motorised transport.

1.6. PROBLEM STATEMENT, MOTIVATION AND SCOPE

The preceding sections have provided a brief background on the transport industry, covering the South African and global experiences. The benefits and problems associated with conventional approaches to transportation have been highlighted and various ideological and technology responses towards a greener transportation era were introduced. It is evident that South Africa's response is characterised by initiatives undertaken by many players, including Government as a procurer of transport goods and services and as a policy maker. Also, greening initiatives are undertaken within the context of many other economy greening efforts. Beside this, there is another challenge of having to justify greening efforts against the well-established traditional systems discussed in the previous sections. The chapter also provided brief background on research conducted in transport greening related topics and highlighted gaps evident in these studies. The author observed that the studies alluded to in the preceding sub-section 1.5.10, tend to focus on either broader issues or on specific transport greening technologies. These include studies on green economy in general or on individual transport technologies such as electric vehicles, planning, transport fuels including compressed natural gas, biofuels, traditional fuels, pollution taxation such as the CO_2 levy or air pollution, etc. These studies lack a holistic approach that examines the transport greening value chain including the demand and supply aspects of fuels and automobile transport industries. Gaps also relate to the lack of documented comparative analysis of South Africa against the world in terms of transport greening performance. This is thus the gap which this research sought to fill, in an attempt to contribute positively to the green economy body of knowledge.

Noting the deficiencies in other studies, the research presented in this thesis scaled up to present transport greening policy and legislative frameworks that cover more than only one greening aspect. The aim was to avoid the temptation to limit the scope to a specific type of initiative or technology. It evaluated past and current policy and legislative provisions. This includes initiatives targeting the reduction in transport related pollution, fuel economy, technology and fuel switch. Technology and fuel switch policy provisions evaluated include those relating to the use of electric vehicles (EVs), compressed gas (natural and human-made biogases), biofuels and fuel cells to power road transport vehicles. It also includes a review of policies relating to modal shift, non-motorised transport, manufacturing of green vehicles and related components. These are all nascent initiatives and technologies that have triggered much interest in the private sector, academia and government communities in this country recently. Certain aspects excluded in the evaluation, however, include civil engineering-related policies with regard to the type of material used in the construction of roads, freeways, bridges, etc. The research excluded a review of policies related to land use changes and travel demand management. Also, the research was limited to road transport, and excluded the marine and aviation sectors. The exclusions intended to reduce the scope, and are highlighted in Chapter 8 as study limitations, with some highlighted as areas that require further research.

While literature exists on policy interventions at an international level, South Africa was deemed behind in terms of specific policies for this sector. To change the current scenario, some kind of transformation in the regulatory framework is often cited as one critically important ingredient needed to facilitate investment decisions. In the developed countries where transport greening has progressed to advanced levels, the policy and legislative levers have played a significant role in creating certainty, hence boosting investor and market confidence. Greening the transport sector is indeed an economic, science, engineering, social, environmental, energy, financial, planning, cultural and political issue. As such, the responsibility in South Africa cuts across the mandates of many organs of state, which are all critically important in the process. The multidisciplinary nature of transport greening called for the application of policy and legislative frameworks borrowed from these diverse fields. While legislative provisions already exist to facilitate a transition to a greener economy, they are scattered and not clearly documented in terms of strengths and weaknesses. They are thus not audible enough to support decision making as they are either not known or are misunderstood across government, industry and the market in terms of their relevance and ability to facilitate a transition to a greener transportation era. The research aspired to contribute to the green economy body of knowledge by providing an academic analysis of the country's policy position and responses to green transport revolution, different from other transport-related studies conducted in South Africa.

1.7. RESEARCH AIM AND OBJECTIVES

Using the transport sector as a case study, the aim of the research was to investigate the South African Government's response to the transition to green economy, highlighting success factors and gaps while providing recommendations on best approaches. The aim was achieved through the following objectives:

1.7.1. Evaluation of policy, legislative and incentive regime governing transport greening in South Africa highlighting the drivers, synergies and gaps,

1.7.2. Exploration of views on the current regime relating to transport sector greening, and

1.7.3. Discussion of findings, comparing and contrasting South Africa with the world, making

- Recommendations, and
- Developing a model to inform policy direction.

1.8. ORGANISATION OF THE STUDY

This thesis consists of eight chapters. Following this (Background) Chapter One, Chapter Two offers a literature appraisal, covering two main areas: views on green transportation as well as the legislative and policy approaches adopted internationally. Views are expressed in the definitions that authors, agents and organisations assign to the concepts of green transportation and green economy. Various definitions assigned to these concepts are thus provided in this chapter. Two models, green transportation pyramid and the Avoid-Shift-Improve (A-S-I) models, are also examined in the chapter. With regard to the legislative and policy approaches, the world is divided into regions examining experiences of countries in the European Union, North America, Latin America, Asia-Pacific and in the Sub-Saharan Africa. The research then focuses on South Africa providing an appraisal of green economy/ transport-related research studies.

Chapter Three examines literature focusing on the conceptual frameworks. Various theoretical frameworks including sustainability theories, systems theories, interventionist theories as well as globalisation theories, are introduced. Here, the relationship between these frameworks, their relevance to the research and how they were used, is also discussed. Chapter Four provides a background on the methodology and research design adopted in the research. It explains the research philosophy, the research approach as well as the research design in terms of data collection, analysis and presentation, under guidance of the onion model developed and promoted by Saunders, Lewis and Thornhill (2009). Chapters Five and Six provide findings of the research to address the first two objectives. Chapter Five provides a detailed review of the South African legislative framework in terms of its response to transport sector greening, while Chapter Six presents views and perceptions on the current policy and legislative regime. Chapter Seven provides a discussion of findings, comparing and contrasting South Africa with the world. It also provides high level policy recommendations and presents a model designed to inform policy thinking and direction in transport greening. It hence addresses the third objective. Finally, Chapter Eight concludes the thesis by presenting a summary of chapters before making recommendations for potential future research.

1.9. CONCLUSION

This chapter has provided background to the research presented in this thesis. It introduced the reader to the status quo of the traditional transportation industry in South Africa and abroad, largely highlighting the environmental challenges associated with this industry. Challenges relate to the adverse impacts of this industry on socio-economic, physical and ecological environments. The chapter highlighted the world and South Africa's status quo in terms of both vehicle and fuels usage production and usage. This is what the author refers to in this document as the 'hardware' and the 'software' of the transport sector industry. South Africa's transport fleet was described as being less efficient compared to the fleet in Europe (South Africa's major trading partner in automobiles). Without any local crude oil reserves, South Africa was depicted as a net importer of transport fuels either in raw material form or as a finished product. As such, the impact of fossil fuel use in South Africa was also discussed, not only on climate change impacts but also on air quality, human health and on the country's economy. It is therefore these very same challenges which the chapter noted, had given rise to ideas around transport sector greening. The chapter further presented transport greening technologies adopted in the world, while also focusing on the actual experiences of South Africa with some of these technologies adopted including fuel improvement, compressed gas powered vehicles, hydrogen fuel cell vehicles, electric vehicles, charging and refuelling infrastructure. These initiatives however require efforts from many players including the state, the private sector, academia and the general public. Global experience as shown in Chapter Three demonstrates the critical role that the state plays in supporting this sector, as demonstrated by many success stories in leading green transport countries.

With this background, the chapter then briefly discussed the problem statement, aim and objectives as well as the rationale for conducting the research. It highlighted gaps in related research studies conducted in South Africa. These are gaps which the author wished to consider by initiating the research presented in this thesis. Gaps relate to the lack of well documented and academic level accounts on the nature of South African Government policy and legislative responses to transport sector greening. It was hoped that by conducting this research, the author would be able to make recommendations that would add value to the country's transition to a greener transportation regime. It was also believed that the investigation would contribute to the green economy body of knowledge. To conclude, this chapter further presented a brief summary of each of the eight thesis chapters including Chapter Two, which is presented next.

CHAPTER TWO

LITERATURE REVIEW ON GREEN TRANSPORTATION PERSPECTIVES AND APPROACHES TO POLICY, REGULATORY AND LEGISLATIVE FRAMEWORKS

2.1. INTRODUCTION

This chapter presents a review of literature on a transition to a greener economy, with the transport sector used as a case study. The chapter is divided into six sections including the current section (introduction). Section 2.2 provides a review of existing worldviews around transport sector greening. This section illustrates that the worldviews in the literature have a great impact on transport greening initiatives globally, including on South African regulatory authorities. The section also introduces the concepts of green transportation and describes the challenges emanating from the absence of a universal definition. It introduces various models for what ought to be done in countries. The models introduced are the green transport pyramid as well as the Avoid-Shift-Improve (A-S-I) models. This section also provides a review of perspectives around the performance of governments, citing examples in the US, the EU and South Africa.

Section 2.3 examines international governments' responses to transport sector greening, highlighting legislative and policy frameworks. It discusses various demand and supply side interventions including the standards and incentive mechanisms used to support the implementation of transport greening initiatives. This literature review section has close linkages with the first objective of this research which evaluates the South African status quo in transport greening policy, regulatory and legislative frameworks as presented in Chapter Five. Section 2.4 briefly examines policy responses in Africa, while South Africa's research in transport greening is covered in section 2.5. Finally, the chapter is concluded with a summary of key issues discussed in the chapter.

2.2. VIEWS ON TRANSPORT SECTOR GREENING

This section provides a review of literature on views around transport greening. As a starting point, views also relate to definitions of 'transport greening' hence the focus of sub-section 2.2.1. The phrase 'transport greening' in this document is used interchangeably with common phrases such as 'sustainable transportation' and 'eco-mobility'. Finding literature on green transportation views proved difficult. Most of literature found and presented in this section focuses on definitional issues as well as specific paradigms that helped shape thinking in sustainable transport. To complement the views inherent within the definitions, a few models are also presented in this section.

2.2.1. Definition dilemmas

The concept of sustainable transportation has been researched extensively according to Zhou (2012). One example includes the article by Noy and Givoni (2018) that provided a critical review of the views and beliefs around the relationship between 'Smart Mobility' and sustainable mobility. The challenge is lack of a uniform definition by these researchers. This creates challenges when attempting to review literature on this concept as the inconsistency means that 'the world has a moving target in the collective effort towards sustainable transportation' (Zhou, 2012). Nijkamp, Verhoef, Ubbels and Rodenburg (2001) noted a similar sentiment as they argued that, despite the critical part this concept has played in influencing approaches to transportation, it is still quite ambiguous. As such, these writers questioned the existence or possibility of a generally accepted definition of sustainable transport. Listing many definitions produced at various times by various global institutions, the Victoria Transport Policy Institute (2017) shared in its TDM Encyclopaedia, related concerns, stating that there is no universally accepted definition of sustainable transportation.

Many attempts to provide a definition, according to Zuidgeest, Witbreuk and van Maarseveen (2000), relate to linking this term to the broader sustainable development debates. According to Cheba and Saniuk (2016), the most commonly used definitions for sustainable transport revolve around environmental sustainability, sustainable transport systems and process sustainability of a transport system. The difference in use depends on how biased each definition is towards sustainable development (social, economic and environment). In their article published in the Journal of Sustainability, Noy and Givoni (2018) viewed the foundation of sustainable transport as the reduction in the need to travel by means of increased use of information and communication tools. This seems to integrate transport greening with smart transportation, something which these writers noted, is still different from the usual sustainability paradigm. As such, they regard sustainable transportation as some kind of radical and critical thinking, suggesting a need to see travel as a valued activity as opposed to a derived demand issue only.

Most of the definitions provided above and those listed it the Victoria Transport Policy Institute (2017) TDM Encyclopedia include social, economic and environmental pillars. Also, Appropedia (2017) viewed sustainable transport as fundamentally a grassroots movement, which although originally driven by environmental (biophysical) concerns, now makes a positive contribution to all pillars of sustainable development including environmental, social and economic pillars. The absence of a theoretically solid conception of the concept of sustainability, according to Purvis, Mao and Robinson (2018), frustrates approaches towards a rigorous operationalisation of the concept. So, in the context of this thesis, it is important to take note of the various definitions and dilemmas highlighted by different authors, especially given the many players involved in South Africa's efforts to green the transport industry. It is, however, crucial to note common reference to the three pillars of sustainable development, i.e. the social, economic and environmental pillars, but at the same time, a policy emphasis on a particular pillar.

2.2.2. Expression of green transportation views in visual models

In addition to considering the many definitions of transport greening, it can be helpful to look at models that depict sustainable transportation systems. In this research, it is argued that these models reflect the views of those who developed them. Most models reviewed during the writing of this sub-section present green transportation in the form of a hierarchy, where the least preferred method is associated with the use of a single occupant passenger vehicle. Carpooling, the use of taxis and buses are the next best modes, with bicycling, walking and use of public transport being the most preferred modes of movement, which according to Lejda, Mądziel, Siedlecka and Zielińska (2017) are being promoted by authorities in European cities. Figure 2.1 portrays one type of green transportation model, aligned with the discussion in this section.

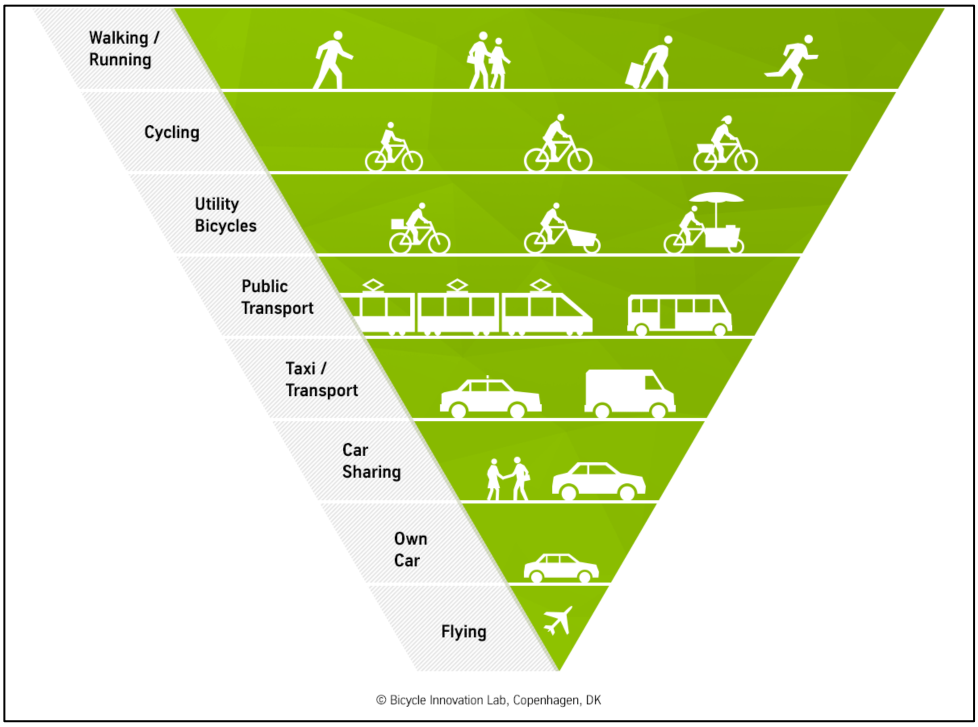

Figure 2.1: Green Transport Pyramid (Urban Hub, 2020)

With the exception of bicycling and walking, the transport modes portrayed in Figure 2.1 involve the use of one form of fuel or another. When more than one person occupies a vehicle, this reduces the amount of fuel consumed and the associated tail pipe emissions compared to when single occupants are using cars. The model in Figure 2.1 has some limitations – it does not make reference to new and alternative vehicles and fuels. As such, it seems limited to addressing efficiency goals as opposed to overall green transportation involving the use of alternative vehicles and fuels. More than twenty years ago, Walsh

(1998) noted that while improvements in internal combustion engines are needed to improve efficiencies, in the long term, zero carbon emitting technologies would be required. Focusing on increased use of diesel technology, according to this author, seems short sighted in this regard, not only because of the increased Nitrogen Oxides (NOx) and Particulate Matter (PM) currently associated with diesel technology, but also because the greenhouse gas reduction potential is so marginal. Technologies involving fuel cells and biomass-based fuels should, according to this writer, play an increasingly important role in solving transportation related environmental problems in the future. Clean mobility does not imply an immediate achievement of 100% green economic system, but rather a phased approach. Morden (2012) argued that a sustainable transport system must be achieved step-wise, not shock-wise, and only then will full cost pricing have a chance to be accepted by market participants and gain sufficient political support. The short-term activity according to Tovey, Woodcock and Osmond (2017), often promotes incremental improvement in fuel efficiency and vehicle emissions controls, while long-term goals include shifting transportation from conventional fossil energy to alternative and greener sources.

As a contribution to the sustainable transportation agenda, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2016) provided a model called A-S-I (Avoid, Shift and Improve) which seems to share similarities with the green transport pyramid model depicted in Figure 2.1. It also contains views which feature in Stafford and Faccer (2014), who called for non-motorised transport options such as cycling, pedi-cabs and walking, as the most energy efficient forms of transport. Contrary to the traditional supply-oriented-approach in transport planning, the A-S-I model focuses more on the demand side. Bongardt and Schaltenburg (not dated) also supported this model when they argued that green transport goals should not only target the reduction in greenhouse gas emissions, air pollution, noise and space consumption, but should also reduce poverty and support economic growth. To achieve these goals, these authors call for the adoption of a holistic approach that will incorporate the avoidance, shifting and improvement of the entire transportation system at the same time. This involves reducing travel distances/ avoiding travelling, shifting to more environmentally friendly modes and improving the overall efficiencies of vehicles and the introduction of alternative fuels. This model is not without limitations, especially in the context of South Africa as discussed in Chapter Seven.

Noy and Givoni (2018) noted that the A-S-I model has not yet been fully adopted in cities and governments around the world, as they are still resolving among others, congestion issues. In this research it is argued, however, that while both the Green Transportation Pyramid portrayed in Figure 2.1 and the A-S-I/ EASI models have limitations, they do however provide useful views on what ought to be done in promoting greening of the transport sector. It allows individuals, entities and governmental agencies to engage in the cause of 'sustainable transportation' (Zhou, 2012).

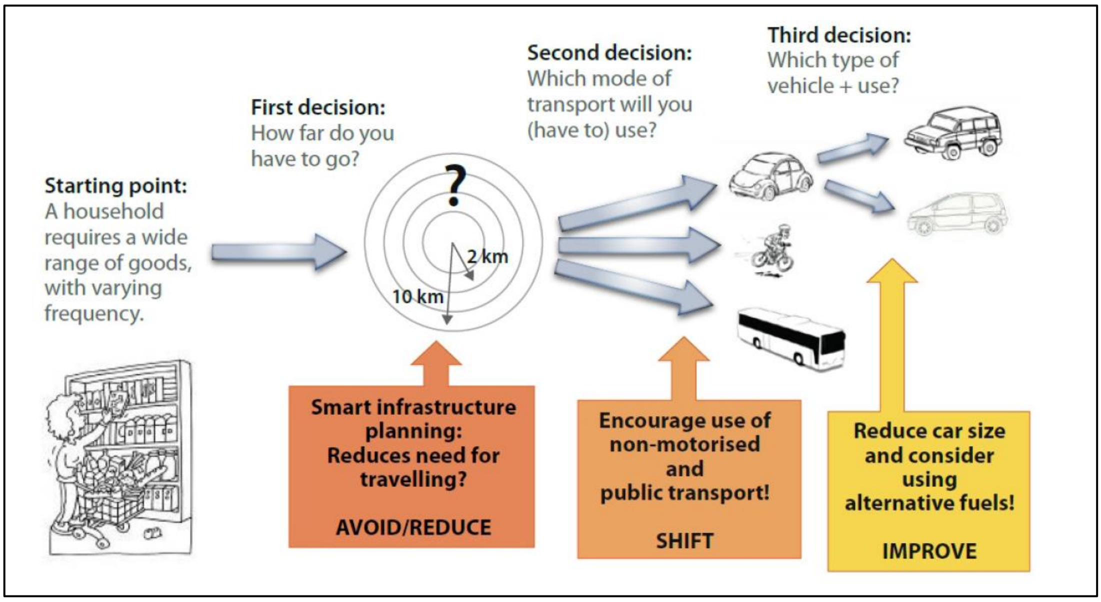

Figure 2.2: The A-S-I Model to Transport Planning (Deutsche Gesellschaft für Internationale Zusammenarbeit (giz) GmbH, 2016)

Banister (2008) provided a series of sustainable transport arguments with strong implications for policy issues presented in section 2.3. These include calls for a few developed nations including the United States, Canada, Japan, Russia, and the European Union member states, to be seen taking an active lead in addressing their own energy usage and emission reduction. This should allow developing nations to 'catch up', while the developed countries slow down their developments. UCDavis and ITDP (2018) also presented an interesting argument in their report. Without specifying who should do what, this report identified three future revolutions in transportation: vehicle electrification, automation, and widespread shared mobility. The policy narrative of each is briefly described below:

- ❒ *Business as Usual (BAU) Scenario* - In most developing countries, the BAU scenario includes almost no support for new technologies, limited capacity for urban policy implementation, and generally continued policy support of (or failure to prevent) strong increases in private motorised travel, with transport infrastructure provision continuing to lag far behind urban growth.
- ❒ *2R Scenario* - The 2R scenario is focused on achieving rapid global adoption of electric vehicles (EVs) from 2020 onward, and a breakout and rapid growth trajectory for AVs (automated vehicles) beginning around 2025. This scenario is otherwise similar to the BAU scenario in the continuation of existing trends for vehicle sharing, public transport use, and urban planning. Many of the measures described here would logically be undertaken at a national level; however, some (such as restrictions on ICE vehicles, coordination of EV charging infrastructure, etc.) would more logically be implemented by cities themselves.
- ❒ *3R Policy Narrative* - The 3R scenario builds on the 2R scenario, with policy support for both electrification and automation, but also substantial policy support for shared-use mobility and urban planning that supports shorter trip lengths and high levels of walking, cycling, and public transport use, even in a future where vehicular travel is significantly less expensive. Without strong policy support for compact cities, even a scenario with fairly high levels of vehicle sharing in smaller

vehicles could result in significantly higher vehicle kilometres and lower levels of access (UCDavis and ITDP, 2018: 32-35).

It must be noted that these scenarios also resemble the A-S-I and the green transportation models introduced above in terms of transport greening initiatives. They all embrace modal shift, alternative fuels, alternative vehicles, public transport, etc. The policy routes promoted by the UCDavis and ITDP (2018) are already evident in the developed world countries. This is true for the 2R and the 3R scenarios. The challenge is developing countries which Banister (2008) argued still require support from the developed world. Due to the lack of resources and other factors, these countries may still be trapped in the BAU scenario.

2.2.3. Views on Government role and performance in transport greening

What is discussed in this sub-section falls within the perspectives of Keynesian economists, who as discussed in the previous chapter, still believe in government intervention. This call is due to, among others, the inability of the 19th century free market system to achieve broader social goals as noted in Mohr et al. (2015). Government can therefore be viewed as an enabler, capable of providing goods and services which the private sector is not able to provide. In this case, Rietveld and Stough (2006) perceived the role of government intervention as the critical ingredient in driving technological change towards sustainable outcomes. Tools suggested include not only the use of taxation policies, but also encouraging public-private partnerships (World Bank Public-Private-Partnership Legal Resource Center, 2019). A similar sentiment was raised in Cohen (2014), who called for a public-private partnership in a transition towards an economy that uses greener resources for energy generation. While private sector’s role is a much larger and even more important than the government’s, effective competition requires strict standards and appropriate punitive measures on inappropriate behaviour (Cohen, 2014). This writer summarised the role of government in building a sustainable economy as follows:

- Funding basic science needed for renewable energy and renewable resource technology.
- Using the tax system, government purchasing power and other financial tools to steer private capital toward investment in renewable energy and other sustainability technologies and businesses.
- Investment in sustainability infrastructure, such as smart grids, electric vehicle charging stations, mass transit, waste management facilities, water filtration systems and sewage treatment systems.
- Regulating land use and other private behaviours to minimise destruction of ecosystems.
- Working with private organisations as well as state and local government to ensure that the transition is well-managed in the real world.
- Measuring our society’s progress toward sustainability by developing and maintaining a system of generally accepted sustainability metrics. This in turn should facilitate the integration of sustainability into our overall management of the economy along with the setting of national sustainable economic policy.
- Transferring sustainability technologies to the developing world (Cohen, 2014).

The perceived role in the last point is also evident in a research article on Jordan's perception of the role of the European Union (EU) in influencing Jordan's environmental policies. In this article, Gerau (2012) presented arguments which sought to suggest the European Union as a self-acclaimed leading actor in global environmental politics. About 75% of the interview respondents in Jordan strongly agreed with this notion. This is closely linked to globalisation theories, explained in Robinson (2007). These theories argue that developed regions use existing global economic and political structures to pursue and enforce their goals to other nations in the developing regions (Major, 2013). Characterised as a global directional (i.e. leading by example) leader, the EU is often seen to be the exporter and advocate of its own ideologies into global environmental agreements, allowing it to exercise regulatory influence to promote own environmental standards (Gerau, 2012). In globalisation theories, the EU is described in Wu (2016) as a core country. These are developed countries, which according to this writer, exercise control over developing (peripheral) countries in many ways including exploitation of labour and raw materials. While the mere externalisation of EU rules and values, according to Gerau (2012), does not always guarantee their implementation, in Jordan, policy makers extensively adopted them. One example of such policy documents is the Action Plan as well as conditions associated with support measures that the European Union provides to this country on environmental improvement matters.

On comparing what is being said about the EU as a directional leader (i.e. leading by example) in environmental policy matters, and the situation in the United States of America, some huge disparities in approaches could be noted. According to Hall (2006), formal policy on sustainable transportation did not exist in the US. There were some regulations and initiatives, as noted by this writer, which however could still not be regarded as a nationwide policy framework. As noted in Lu (2018); Zhang, Xie, Rao and Liang (2014) and Baran, Fernando and Legey (2013), the situation seems to have improved in the USA. These writers discuss various policy interventions implemented to promote the adoption of transport greening technologies, which include, among others, electric vehicles and biofuels.

In South Africa a number of research studies have been conducted in public transport policy. Most of these are briefly introduced in sub-section 1.5.10 in the preceding chapter. They include Suleman, Gaylard, Tshaka and Snyman (2015); Moodley et al. (2011); Holtzhausen and Abrahamson (2011); Vosper and Mercure (2016); ERC (2013); Mitchel and Walters (2011) and a study by **the dti** (2016). Major issues highlighted in these studies include lack of coordination and integration as well as deficiencies of programmes such as the CO_2 levy in changing behaviour. These reflect perspectives of individual authors on South Africa's transportation regime. Luke and Heyns (2013) conducted an annual survey of 1000 South Africans to gauge opinion on transport related matters. Numerous opinion polls have been conducted in various parts of the world including polls in New South Wales in 2011, the quarterly polls by the University of Sydney, regular surveys by the European Commission as well as regular surveys by Transportation America. With the exception of a few polls such as the 2003 National Household Travel Survey, there is evidence of a limited number of such polls conducted in South Africa. In their 2013 opinion toll, Luke and Heyns (2013) compared public opinion to actual public transport policies, arriving at the following results:

- Public transport is by far the highest priority issue in transport in South Africa today.
- Principal concerns pertaining to public transport are the provision of services, the safety and reliability of public transport, mobility and accessibility, affordability and quality of infrastructure.
- Local and national government are both perceived to be most responsible for the provision of transport. National government: 36.2%, Local or Municipal or Metropolitan area government: 33.5%
- Over 53% respondents viewed the private sector as far more involved in the provision of public transport (Luke and Heyns, 2013: 6).

The focus in this survey was not necessary on green/ sustainable transportation, but on public transport. In the green transportation pyramid depicted in Figure 2.1, however, public transport is one of the green transportation modes.

According to the IDC and **the dti** (2017), South Africa is green economy friendly, with the main problem being lack of implementation. Using the e-mobility sector as a case, ERC (2013) stated its views on the country's regulatory and policy context, citing lack of a coordinated approach between the departments. They criticise the Department of Transport for not prioritising green transport and the Department of Trade and Industry for failing to incorporate electric vehicles in its automotive industry support schemes. They further viewed the country's EV Industry Roadmap as a programme that the Government did not hold in high regard. The proposals made in the roadmap are deemed to be an attempt to make investments without taking significant risks. The Department of Environmental Affairs on the other hand includes EVs in the flagship programmes as a way of encouraging energy efficient-vehicle technologies. It however wants 'the country to keep abreast of developments, be ready to move in the direction of greater e-mobility but not to invest too heavily in this area while there is significant market risk and uncertainty' (ERC, 2013:3).

While the role of government interventionist policy approaches is often criticised by supporters of classical and neoliberal economics, WebFinance Inc. (2017) partially supported this approach, especially in times where the intervention is required to address specific injustices. But what the role of Government in transport greening should be exactly, is very much discussed in NGV Journal News (2018) which cited various case studies from the natural gas vehicle industry. Examples of possible actions that could be undertaken include:

- *Mandates/ Directives:* these are an effective measure, provided they are monitored correctly by authorities. These can apply to vehicle fleet owners, such as mandating that a particular percentage of vehicles should be green. They can also apply to energy suppliers, requiring them to provide alternative fuel, or filling stations to supply green fuels.
- *Technology support:* support can be provided either through direct grants or tax concessions for product development, emissions testing or compliance and homologation costs. This lowers costs and risks for the manufacturer and, ultimately, the consumer. Technology support can also be provided by amending existing rules for used vehicles. These are rules that would otherwise limit innovation by Original Equipment Manufacturers (OEMs) and vehicle converters.
- *Direct funding*: with grants or rebates provided to the buyers of green vehicles or conversion systems, governments can offset the additional costs incurred by the vehicle owners. These schemes should however be aligned with schemes that also encourage use of green fuels once the vehicle has been purchased or converted.
- *Lower tariffs:* Countries which rely on imported equipment for green vehicles can provide support by reducing or eliminating import tariffs on equipment and components. These could be applied not just to vehicle and engine components, but also to refuelling equipment, fuel cylinders, etc.
- *Preferential benefits:* Governments can encourage green vehicle ownership by providing owners with preferential benefits such as:
    - lower registration costs,
    - reduced or eliminated parking charges,
    - free access to high-occupancy-vehicle (HOV) or transit lanes on freeways, and
    - reduced or eliminated congestion charges.

It should still be noted that movements towards sustainable transport, according to Rietveld and Stough (2006), are influenced by institutional conditions, which could either benefit or hamper development. As such, institutions may be both supporting and constraining, depending on the situation. Examples of institutional constraints identified by Rietveld and Stough (2006) include citizens' rights which make it difficult for the state to introduce certain greening tools, e.g. parking restrictions, increased levying of polluting fuels, and international agreements on taxation. The point that this writer makes is that Government is at times viewed as constrained by institutional arrangements. Nonetheless, section 2.3 presents literature reviewed on the actual policy tools adopted by governments in the leading transport greening countries. It is argued in this research that decisions linked to any of these tools has been influenced by the world views similar to those presented in this sub-section.

2.3. POLICY INTERVENTIONS IN LEADING TRANSPORT GREENING COUNTRIES

Transport greening is a planning issue and as such, it is worth noting recommendations made by Eddington (2006) regarding improvement in how world governments should handle it. Correct decisions on both transport infrastructure and service-patterns, according to this writer, need to be made from the start. This calls for a need to provide very clear objectives and desired outcomes that transport policies seek to achieve. It also requires a need to clarify the practical challenges prior to arriving at the final choice. The sequence involves ensuring that policy making starts with the goal or problem, before assessing potential solutions, not the opposite. Sustainable transport policies have their greatest impact at the city level, with some writers such as Banister (2008) arguing that the right policies are already known.

Schiller, Bruun and Kenworthy (2010) also noted that many of the inefficiencies of traditional approaches, services and programmes in the transportation arena stem from public policies whose shortcomings can be largely understood by using economic analysis. Most economists, according to these writers, agree that costs that were previously externalised should now be internalised. The internalisation of transportation costs can be brought through the use of many command and control oriented tools. These could include fiscal and monetary policy measures such as the imposition of price controls to prevent unduly high prices, imposing tax on the full excess profits of monopolies or regulating monopolies through competition policies. These tools are not without their own challenges (Mohr et al., 2015: 278) and economists contend that market failure does not necessarily provide sufficient grounds for government intervention. Governments in the leading green transportation countries have nonetheless continued to intervene by implementing measures aimed at greening the transport sector.

Fuel economy regulations, according to Miller and Facanha (2014), were first implemented in the USA in the 1970s to reduce vulnerability to the price volatility of oil imports. The initial driver in the EU according to Nesbit et al. (2016) was not necessarily addressing environmental objectives, but rather the safety objectives and to ensure that vehicles did not disrupt the internal market. Japan and the EU used financial instruments as well as the regulatory framework to encourage the adoption of fuel-efficient automobiles. This is true for Europe, Japan and China as noted in the work of the International Council on Clean Transportation (2014) alluded to in the subsequent sub-section. In these same countries, since mid-2000, governments, according to these writers, introduced policies to promote alternative fuels and vehicles. This was a further green transportation development from the early interventions that had focused on vehicle fuel economy. The top clean vehicle markets that Miller and Facanha highlighted accounted for more than 84% of global vehicle sales in 2013 and included China, USA, EU, Japan, Brazil, India, Russia, Canada, South Korea, Australia and Mexico. They designed policy frameworks with numerous targets, including enhanced vehicle efficiencies right through to the adoption of alternative fuels and vehicles (Miller and Facanha, 2014). For some of these countries, this forms part of their transport decarbonising strategies such as that of the European Union (EU) 2020 strategy and of the Common Transport Policy (European Expert Group on Future Transport Fuels, 2011). The main clean and alternative transport technologies adopted globally include vehicles propelled by electric, compressed gas, bio-derived liquid fuels and more recently, vehicles powered by hydrogen fuel cells. Some vehicles are powered by the combination of any of the two systems (hybrids).

Zhang, Xie, Rao and Liang (2014) highlighted two types of financial incentives that have been utilised successfully in some of these countries, i.e. demand side incentives targeting consumers and supply side incentives targeting manufacturers. Demand side incentives, mainly contain fiscal and monetary measures such as tax credits, tax reduction, tax exemption or direct subsidy during purchasing of vehicles, as well as low interest rate on borrowing. They include many more incentives to manufacturers, which these writers discussed. In the case of fuel targeting incentives, these authors recommend ensuring that the price of alternative fuel is equal to or lower than that of conventional fuels. This is the policy stance behind South Africa's development of the incentive mechanism for biofuels, discussed in Chapter Five.

As discussed in the following sub-section, a number of countries in Europe provided incentive schemes targeting consumers of electric vehicles. Some countries have extended the benefits to fuel cell and electric vehicles as well as conversion of traditional internal combustion engine vehicles to use greener fuels. Commencing with the European Union (EU), various support tools adopted at international levels are discussed in the following section. The discussion includes natural gas and biological fuels, but excludes green transportation initiatives such as modal shift, public transport, walking and cycling.

2.3.1. The European Union (EU) policy interventions and support schemes

In the 1970s, the early responses to transport greening in the European Union did not focus on addressing environmental objectives, but rather addressed safety, oil crisis and market protection objectives (Nesbit et al., 2016). Only later, around the early 90s, did the legislative framework on automotives address environmental impacts, specifically air quality, with the requirement for compulsory fitting of catalytic converters in petrol powered vehicles. The first Carbon Dioxide target was set around 1998, through a voluntary agreement between the European Commission and the Automobile Association (Nesbit et al., 2016). By 2013, the EU, according to the International Council on Clean Transportation (2014,) had reached some consensus on carbon dioxide reduction targets for new automobiles as indicated below:

- Reduction of specific CO_2 emissions from 2012 below 130g CO_2 /km and 120g CO_2 /km considering biofuel share. This applied to all new vehicles within the EU. By 2020, there was a target of 95g/CO_2 /km for all new passenger vehicles, phasing in for 95% of vehicles in 2020 with 100% compliance in 2021. This corresponds to about 3.8 litres per 100 kilometre (l/100km) of fuel consumption;
- The light-commercial vehicle target was 147 g/km of CO_2 for 2020, which corresponds to about 5.6 l/100 km. There is a penalty proposal for OEMs that fail to comply, the severity of which increases year by year from 2012. Producers could also gain so-called "super credits" if they produced vehicles with extremely low carbon dioxide emissions (International Council on Clean Transportation, 2014).

To support the implementation of these policy measures, Figure 2.3 provides a schematic diagram of early support schemes that the European Union made available to the producers and consumers of automobiles.

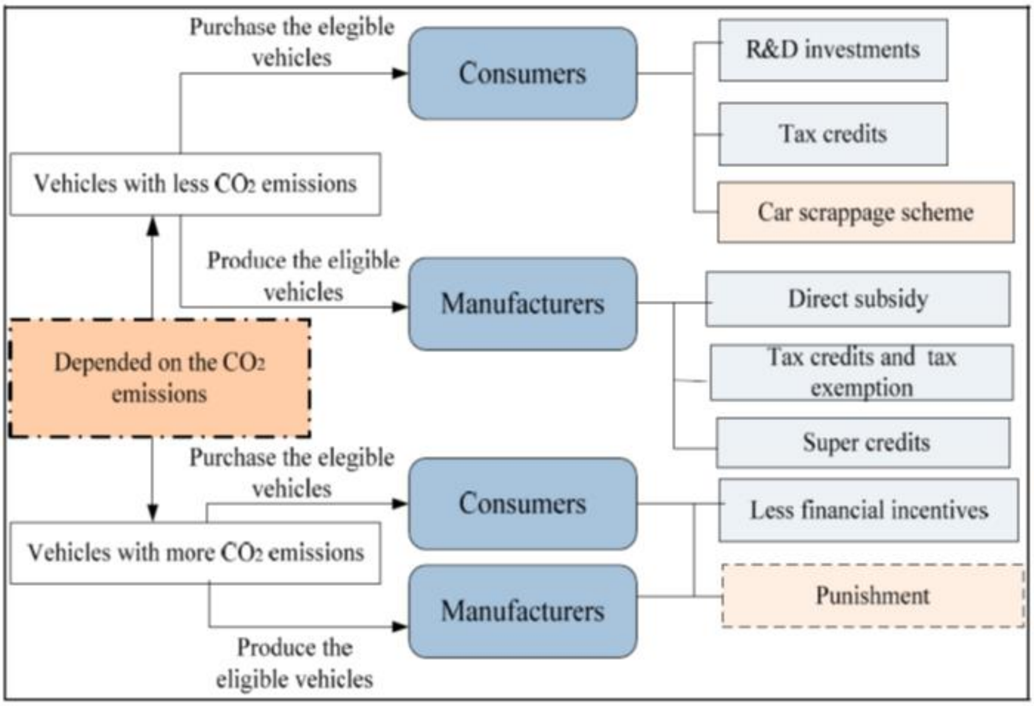

Figure 2.3: The incentive mechanism in Europe (Zhang, 2014)

These schemes are largely financial tools ranging from tax credits, tax exemptions, research and development support, subsidies and car scrappage schemes. While Figure 2.3. shows positive support measures that targeted both the supply and demand side, it also shows punitive measures associated with failure on the part of vehicle producers and consumers to comply with the policy provisions that target the reduction in carbon dioxide emissions. In 2014, the International Council on Clean Transportation (2014) compared the EU standard of 95g/km for 2020 (effectively 2021) with targets in other parts of the world. This institution concluded that the EU standard is the most stringent in terms of size and commencement date. Nesbit et al. (2016) confirmed this when they stated that the EU has relatively stricter standards than the USA when it comes to the control of greenhouse gas emissions. On average, these authors found that the EU standards are lenient when it comes to air quality, with the USA, specifically California standards being the most stringent. There are other countries like Germany, Denmark and Norway, however, who (like the USA) have developed policies that are deemed not to be dependent on carbon dioxide emissions.

2.3.1.1. EU support for Electric Vehicles.

The EV support schemes adopted in the EU ranged from charging infrastructure support, support for Research and Development and direct funding as well as tax exemptions/ rebates to consumers of fuel efficient vehicles as shown in Table 2.1. In Norway (a country with the largest market share for new electric vehicle sales between 2013 and 2017, and the closest ICE ban target of 2025), Government set the goal to reach 50,000 zero emission vehicles by 2018 (IEA, 2018). This country recorded an electric car stock of 249 units in 2019 (International Energy Agency, 2019).

Table 2.1: Early policy and incentive measures in EVI countries (IEA, 2013)

EV MEMBERS	FINANCIAL	INFRASTRUCTURE	RD & D
Denmark	Exemption from registration and road taxes.	DKK 70 million for development of charging infrastructure.	Focus on integrating EVs into the smart grid.
Finland	EUR 5 million reserved for vehicles participating in national EV development programme, ending in 2013.	EUR 5 million reserved for infrastructure as part of the national EV development programme, ending in 2013.	None provided
France	EUR 450 million in rebates given to consumers buying efficient vehicles, with 90% of that amount from fees on inefficient vehicles. Remaining 10% (EUR 45M) is a direct subsidy.	EUR 50 million to cover 50% of EVSE cost (equipment and installation).	EUR 140 million budget with focus on vehicle RD&D.
Germany	Exemption from road taxes.	Four regions nominated as showcase regions for BEVs and PHEVs.	R&D for electric drivetrains and battery research.
Italy	EUR 1.5 million for consumer incentives, ending in 2014.	None provided	None provided
Netherlands	Tax reduction on vehicles amounting to 10-12% net of the investment.	400 charging points supported through incentives.	Focus on battery RD&D (30% of 2012 spending).
Spain	Incentives up to 25% of vehicle purchase price before taxes, up to EUR 6,000. Additional incentives of up to EUR 2,000 per EV/PHEV also possible.	Public incentives for a pilot demonstration project. Incentives for charging infrastructure in collaboration between the national government and regional administrations.	Five major RD&D programmes are operational with incentives for specific projects.

Sweden	EUR 4,500 for vehicles with emissions of less than 50 grams of CO2/km. EUR 20 million for 2012-2014 super car rebate.	No general support for charging points besides RD&D funding (EUR 1 million in 2012).	EUR 2.5 million for battery RD&D.
United Kingdom	None provided	GBP 37 million for thousands of charging points for residential, street, railway, and public sector locations. Available until 2015.	The UK Technology Strategy Board has identified 60 collaborative R&D projects for low-carbon vehicles.

In addition to fiscal incentives, Norway provided other non-fiscal measures such as zero charges on parking bays and free access to bus lanes, similar to the US. Also, they developed and supplied charging infrastructure available free of charge to electric car users. Due to high costs of petroleum fuel in this country, this was well-received by this country's road users. Norway used various financial and non-financial incentives to stimulate the uptake, most of which were in effect until the end of 2017 or until the 50,000 EV target is achieved (IEA, 2018). As the largest EV markets in 2016, Lu (2018) of the US Environmental and Energy Study Institute published an article comparing the United States and China in terms of their approaches to EV roll-out. In both countries, policy support is argued to have played a major role in developing and deploying EVs, since these are still at a disadvantage compared to traditional vehicles. Like in Norway, the USA also adopted policy instruments that included a combination of fiscal instruments.

It should be noted that, further to the early policy interventions portrayed in Table 2.1, many developments have taken place in the EU since 2013. These include policy developments in 2018 and 2019, which largely support the uptake of EVs and the roll-out of charging infrastructure as noted in the Global EV Outlook by the International Energy Agency (2019). These include regulations on vehicles, new incentives on vehicles, industrial policies and regulations on chargers as well as targets for the roll-out of charging infrastructure. The key feature of these updated vehicle policies include the adoption of new CO_2 emission standards for light duty vehicles (LDVs). By 2030, the standard requires these vehicles to reduce CO_2 emissions per km by 37.5% compared with the 95 grams of CO_2 per kilometre requirement for 2021. It also requires that new vans reduce this by 31% compared with the previous 147gCO_2/km requirement for 2020. The policy allocates a specific emissions target for each manufacturer, with EV production thresholds set to encourage the sale of more zero- and low-emission vehicles, irrespective of whether they are fully battery electric (BEV) or plugged in hybrid (PHEV). The reward involves the adjustment of CO_2 reduction targets, allowing for less strict overall target to the manufacturers that do their best to exceed the stringent target. The European Parliament according to the International Energy Agency (2019) further revised the Clean Vehicles Directive on public procurement, stipulating minimum requirements of 17.6% in 2025 and 38.5% in 2030 for the addition of clean vehicles in public procurement. It is also mandatory for countries in the European Union to set deployment targets for publicly accessible chargers in 2020, with targets also required for 2025 and 2030 as part of these countries' national policy frameworks. While the EU support for electric vehicles is acknowledged, it must however be noted that this region also supports the deployment of other transport greening programmes such as the use of biofuels discussed in the following sub-section.

2.3.1.2. EU support for biofuels

Regarding biofuels, Belincanta, Alchorne and Teixeira da Silva (2016) wrote about the EU Renewable Energy Directive (RED, 2009/28/EC), which requires that 20% of energy produced come from renewable sources. All EU countries are therefore required to make sure that by 2020, a minimum of 10% of their transport energy emanates from renewable sources. The European Commission (2018) cited the importance of biofuels in achieving this target. As such, the directive sets out biofuels sustainability criteria as follows:

- Biofuels should be able to attain at least 35% savings in greenhouse gas reduction compared to fossil fuels – a requirement which rose up to about 50% and 60% in 2017 and 2018 respectively, in new production facilities. The calculation takes into account all life cycle emissions including those emanating from farming, processing, and transportation;
- Biofuel plant farming is prohibited in such areas as wetlands or forests; and
- Raw materials cannot be sourced from areas of high biodiversity including natural grasslands and primary forests (European Commission, 2018).

Revelations Instruments (2018) and Belincanta et al. (2016) noted that the Fuel Quality Directive (FQD, 2009/30/EC) set specifications for petrol, diesel and gasoil, while also introducing a mechanism to monitor and reduce greenhouse gas emissions. It set regular blend maxim at 10%v/v of ethanol (E10), or oxygen maximum content of 3.7%m/m. The Directive required 6% reductions by 2020, in greenhouse gas emissions intensities from transport fuels (Concawe, 2016). It made provisions for support schemes, which could include but are not limited to, investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes including those using green certificates, and direct subsidy schemes including feed-in tariffs and premium payments (Alabrese, 2015). Member states came up with different incentive mechanisms, but to qualify for financial support, biofuels had to reduce greenhouse gas emissions while also ensuring that raw materials are not sourced from land that has high carbon stock or high biodiversity value (Alabrese, 2015).

The Directive also required that biofuels sold had to meet European sustainability standards, with Solorio and Jörgens (2017) critiquing the implementation of both the FQG and RED directives for having been less effective (in specific member countries like

Netherlands) compared to the 2003/30/EC Directive. Even though the latter focused on first generation biofuels, Solorio and Jörgens (2017) praised its role in encouraging the development of biofuels market in the Netherlands for four years.

2.3.1.3. EU support for Natural Gas Vehicles

Fevre (2014) noted that most green transport programmes cover areas related to the standard of fuel used, the design of the internal combustion engines (ICEs) as well as the infrastructure required for greener fuels. In the EU, what complicates matters is the fact that such initiatives crosscut between various departments, causing an inevitable overlap and hence uncertainty regarding future objectives. Across the EU, the picture is deemed not to be uniform, with some countries (notably Germany and Italy) promoting Compressed Natural Gas (CNG), while others such as Norway, Spain and the UK promoting Liquefied Natural Gas (LNG). Globally, Natural Gas Vehicles (NGVs) are growing, but more in Asia Pacific and in Latin America compared to the EU. Fevre (2014) went on to say, while in the EU there is general support for gas technology use in transport, this region is well aware of other greener alternatives, and as such these have been given more attention. Nonetheless, countries in Table 2.2 have adopted various NGV support measures as shown below.

Table 2.2: EU Country Support Schemes for NGVs (NGV Global News, 2018)

Country	Green Transport Support Scheme
Italy	Italy had over 75% of NGVs in the EU. With more than 30 years in the gas industry, the oldest retrofit industry dates back to the 1970s. Government incentives of over 25 million euros made available via specialised workshops and dealerships, ranged between 650 to 2400 euros / vehicle.
Sweden	Has most CNG buses than the European Union average. They provide fiscal incentives on the fleet of private entities, and grants to bus entities.
Netherlands	Initially, mostly LNG but later addition of CNG. Government allocated over 3.74 million US dollars in subsidies on private entities.
France	France – has been running CNG since mid-1990 mainly on buses and garbage collection trucks. Also LDVs and cars (mostly fleet). Specific incentive for buying NGVs removed in 2011 after Government felt that it had achieved the target. Natural gas also got exemption from paying tax, which it was feared was going to be removed in 2014.
UK	Both CNG and LNG. Funding through the Low Carbon Vehicles Innovation Platform. Low Carbon Truck demonstration trial – very small applications though to date.
Norway	This country discovered potential use of liquefied natural gas as bunker fuel, hence allocating over 70 million-dollar subsidy to facilitate conversion of ships accordingly.
Switzerland	They set a 10% biomethane quota in natural gas blend. This resulted in the gas industry putting money resources in developing needed infrastructure.
Russia	Gasoline is relatively cheap, hence providing less incentive of natural gas use in vehicles. Government, however, has set some NGV and infrastructure roll-out targets by 2020 and 2030 respectively.

Germany on the other hand proposed a 20% blend of biogas with natural gas and guidelines for subsidies for energy-efficient, low-carbon trucks using CNG and LNG (NGV Global

News, 2018). Germany's recent pronouncement came after the conclusion of the EU's Blue Corridor Project, which is deemed to have done much to make natural gas a well-known and acceptable energy source for transport in this region. As such, Germany's announcement could significantly boost the gas market in the EU. On its website, the European Automobile Manufacturers' Association (ACEA, 2020) published a plea, with two other associations (European Biogas Association (EBA) and the Natural & bio Gas Vehicle Association (NGVA) - Europe) to the EU policy makers. This plea is about a need to speed up the deployment of infrastructure for natural gas and biomethane to cover the entire EU region. Adopted by the European Parliament and the Council in September 2014, a Directive on Alternative Fuels Infrastructure (DAFI), requires EU member states to erect such infrastructure by 2025 (Fuel Cell Electric Buses Knowledge base, 2020). While catering for electricity, CNG, LNG and hydrogen, the requirement for CNG and LNG in this directive is as follows:

- Install CNG infrastructure at least every 150 km on TEN-T Core Network and one CNG refuelling point per estimated 600 CNG vehicles.
- Install infrastructure for LNG for vehicles at least every 400 km on TEN-T Core Network.

The three associations further called for support aimed at integrating and promoting use of renewable gas in the market as well as a need to maintain support for research and innovation through designated funding schemes. All these pleas are targeting the road transport industry. In rolling out this infrastructure, NGVA (2020) emphasises a need for EU member states to speed up the implementation of the 2014 Directive and harmonised standards. The association argues that such infrastructure is required to facilitate a homogeneous market throughout Europe, with harmonised EU standards needing to be implemented at national levels.

2.3.2. North America's Government Schemes for Green Transportation

The approach in the USA resembles the European Union's approach discussed in the preceding sub-section, with slight differences as illustrated in Figure 2.4 which illustrates different incentive schemes made by the USA government to producers and consumers of automotive goods and services. The schemes involved the use of demand-pull and supply-push financial incentives as described in Hardman et al. (2018). These incentives include the use of direct subsidies, tax credits and exemptions, cash on the return of used vehicles, research and development (R&D) investment support, rebates and government procurement as described in Slowik, Hall, Lutsey, Nicholas and Wappelhorst (2019). Other tools portrayed in Figure 2.4 include the use of non-financial incentives such as free access to high occupancy vehicle lanes. Most efforts in the USA according to Baran et al. (2013) are driven not only by environmental concerns, but also by the need to maintain energy security. Electric vehicles (as discussed in the next sub-section) have the potential to reduce dependence on imports and curb the emission of greenhouse gases.

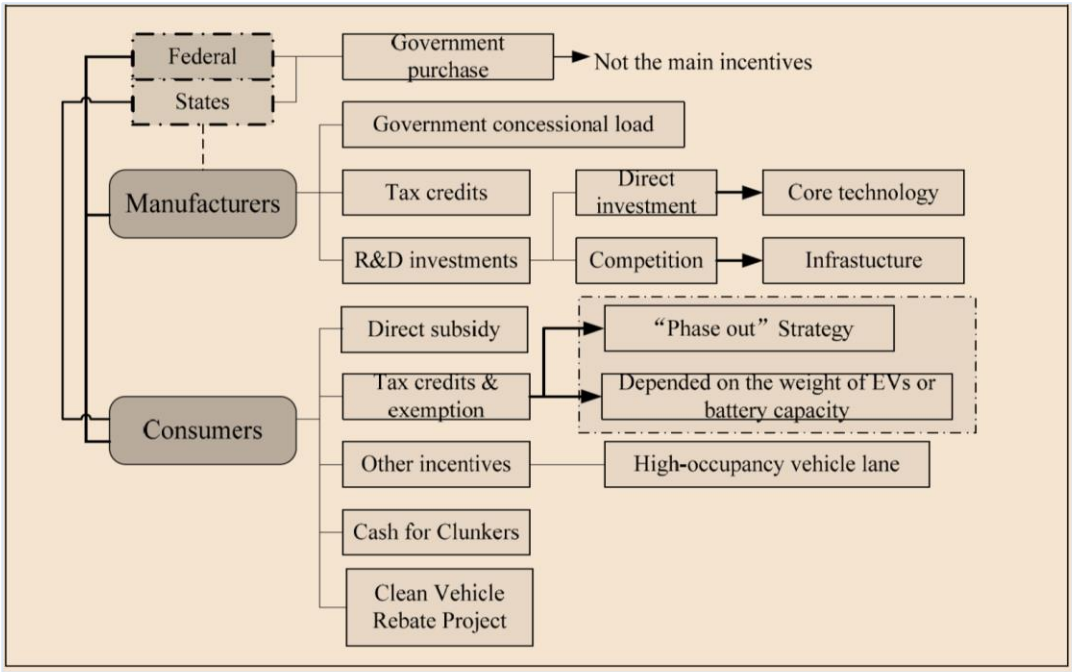

Figure 2.4: Framework of green transport support incentives in the USA (Zhang et al., 2014)

The policy tools of various states and federal government include provisions in, amongst others, the Energy Policy Act (EPAct of 2005), the Energy Improvement and Extension Act of 2008 and the American Clean Energy and Security Act of 2009 (Zhang et al., 2014). To promote a move towards alternative fuels and vehicles, the USA government used various legislative clauses, with specific support tools for each green transport technology adopted, briefly discussed in the following sub-sections.

2.3.2.1. US support for electric vehicles

Regarded as one of the forward-looking climate change policies, the Zero Emission Vehicle (ZEV) programme is a California state regulation that allows original equipment manufacturers (OEMs) of internal combustion vehicles to earn a certain number of credits by selling zero emission vehicles (Forbes Media LLC, 2017). This is a supply-push scheme which Hardman et al. (2018) described as having been adopted not only in the USA, but also in the Canadian province of Quebec in 2016, via the ZEV Act. The vehicles concerned include Battery Electric (BEVs), Plugged-in Hybrids (PHEVs) and Hydrogen Fuel cell vehicles, sold in California and other states including Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, and Vermont (Center for Climate and Energy Solutions, 2019). Focusing on encouraging these automakers to research, develop and market zero emission vehicles, the scheme assigns each automaker "ZEV credits" (equal to a set percentage of non-electric sales) which they are required to maintain (Hardman et al., 2018). Each car sold earns a number of credits based on the type of ZEV and its battery range. The credit requirement was 7% in 2019, which would require about 3% of sales to be ZEVs. The credit requirement rises to 22% in

2025, which will likely require less than 8% of sales to be ZEVs. An automaker selling 100,000 cars in California in 2018 will need at least 7,000 ZEV credits, with at least 4,000 coming from battery-electric or fuel cell vehicle sales. However, this does not mean they will need to sell 7,000 electric cars and trucks to comply, as most ZEVs generate more than one credit per vehicle (Hardman et al., 2018).

2.3.2.2. US support for biofuels

Major policy initiatives in the USA according to Guan and Oh (2018) include biofuel mandates and tax credits. These writers noted that the US government's support for alternative fuels started with the Energy Tax Act of 1978, which made provisions for tax exemptions of up to US$0.40 per gallon of ethanol produced, increasing up to US$0.54 per gallon in 2000 and further down to US$0.45 per gallon in 2010. Similar to the tax credits from the federal government, individual states also offer tax credits and breaks for the production and use of ethanol (Belincanta et al., 2016). In addition to the fiscal policy instruments, the mandates that government used included provisions in the Energy Policy Act and the Energy Independence and Security Act (EISA) of 2007. These legislative frameworks led to the establishment of the Renewable Fuel Standards (RFS), which according to Guan and Oh (2018), set specific targets for biofuels addition into the transportation fuel mix. These standards are applicable to refineries and importers, and include a requirement to increase annual biofuel production from 9 billion gallons in 2008 to 36 billion gallons in 2022.

In its website, the US Department of Energy (2020) provides a list of federal laws and incentives, which are related to biodiesel. One such incentive is the Biomass Crop Assistance Program, which provides funding aid to the owners of land and operators that establish, produce and deliver biomass feedstock crops for advanced biofuel production facilities. The scheme provides reimbursement of up to 50% of the cost of establishing a biomass feedstock crop, as well as annual payments for 5-15 years for feedstock. Government also provides Advanced Biofuel Production Grants of up to 50% of project costs and Loan Guarantees of up to $250 million for the development, construction, and retrofitting of commercial-scale bio refineries that produce advanced biofuels (US Department of Energy, 2020).

Besides government mandates and fiscal tools adopted by states, Guan and Oh (2018) cited the important role of market forces in accelerating the production of biofuels. Energy prices remained high for an extended period of time after the 2008/09 recession, and crude oil prices reached a record of US$140 per barrel which, according to these writers, increased the pace of developing biofuels. While Guan and Oh (2018) acknowledged the existence of different opinions regarding the actual impact of the US fiscal policy and mandates on biofuels, they noted that, following the implementation of these tools, the production of biofuels dramatically increased in the USA.

2.3.2.3. US support for Natural Gas Vehicles

The Alternative Fuel Infrastructure Tax Credit was to expire in December 2016 but was extended until the end of December 2020 (US Department of Energy, 2020). This scheme makes the installation of fuelling equipment for natural gas eligible for a tax credit of up to 30% of the total cost of the project. As explained in this department's website, this incentive also applies to the erection of infrastructure for other cleaner fuels such as propane, liquefied hydrogen, electricity, diesel fuel blends containing a minimum of 20% biodiesel. NGV America (2020) notes that natural gas vehicle incentives offered by almost every state government in the US include grants, tax deductions/credits, fuel tax reductions, reduced license fees, reduced vehicle sale taxes and lower registration fees. This institution is also of the view that natural gas deserves tax parity when compared with other vehicle and field incentives. It is taxed at different rates from state to state, with the possibility of rates charged for exceeding rates imposed on gasoline and diesel fuel. In summarising the NGV situation (as of 2016), the International Gas Union (IGU, 2018) made the following statements:

- Natural gas is abundant and the ~1.5 mil pipeline covers much of the country.
- CNG and LNG station network is expanding but the US is a large landmass to cover and many gaps exist.
- Light/medium duty OEMs are available in various popular models mostly from SVMs delivered through the OEM chain (warrantied buy not manufactured).
- Heavy duty vehicles are available but the engines are limited to mostly Cummins systems.
- Cost of the natural gas vehicle systems are high.
- Standards and regulatory frameworks are well-developed.
- Government support and incentives are intermittent, leaving much uncertainty for purchasers.
- Natural gas industry needs to purchase NGVs for their own vehicle fleets.
- Biomethane will play a more important role as part of the overall CO_2 reduction strategy.
- LNG vehicles and stations will grow.
- Marine applications will become more important and ports will provide a place for crossover with LNG trucks.
- Market growth tied to gasoline and diesel price.
- Environmental benefits are more important now than ever (International Gas Union, IGU, 2018:24).

The debate continues as to whether natural gas should continue to be used or not. Brinson (2020) argued that, while there is plenty of this gas in the United States, it is an eco-friendly yet flawed source of energy. While it is not as clean as renewable energy sources such as wind or solar, because of its abundance in the US, many consider it a transitional fuel to other cleaner energy sources.

2.3.3. Asia-Pacific governments' support measures for green transportation

Asian countries have adopted a number of green transportation technologies, ranging from electric vehicles, compressed gas powered vehicles to biofuel powered vehicles. The following sub-section examines drivers and tools used to promote these technologies.

2.3.3.1. EV roll-out (with China as an example)

While China is not the only country in the Asia Pacific region that has introduced measures to encourage the adoption of electric vehicles, it is by far still Asia's leading country in electric vehicle sales, and also a global leader in EV volumes in 2017. It held the world record of about 40% electric vehicle stock – an achievement which the International Energy Agency (2018) attributed to this country's robust implementation of special support measures discussed in this sub-section. Up to 2018, China remained the world's largest electric car market followed by Europe and the United States (International Energy Agency, 2019). Ou, Hao, Lin, Wang, Bouchard, Przesmitzki, Wu, Zheng, Qi and LaClair (2019) recorded China's global market share at 56%, with about 1.2 million electric vehicles this country sold in 2018.

While China has developed various policy measures aimed at stimulating the demand for electric vehicles, the two most influential demand-pull measures were implemented at central and local government levels. The first measure introduced at central government level was the subsidy of 5065 US dollars to 8683 US dollars per vehicle in 2013 (Ou et al., 2019). According to these writers, on average, the subsidy for BEVs accounted for about 25% of the automobile price, and about 10% for PHEVs, indicating preferences for fully electric vehicles. The subsidy is claimed directly by the auto maker, not by the buyer, thus reducing the paperwork burden on the consumer. To reduce government intervention in the market, this subsidy kept declining, reaching about 3618 US dollars in 2019, with a plan to end it in 2020 (Ou et al., 2019). The second key demand-pull measure introduced at local government level was the preferential treatment on EV registration. Yingqun (2017) noted that in China's Beijing, this made it extremely difficult for traditional fuel-powered vehicles to get a license disk, compared to getting a similar disk for an electric car. Megacities often had strict registrations, limiting new vehicle registrations to control rapid growth of vehicle population. Vehicle owners in Beijing are also exempted from even trying their luck in a 'license plate lottery' or 'licence plate bidding' in Shanghai, Hangzhou and other metropolitan cities. The average bid price in Shanghai for a license plate for an ICE ranged from 12677 to 13571 US dollars, reaching about 18813 US dollars in Beijing (Ou et al., 2019). This amount is additional to the Manufacturers Suggested Retail Value (MSRV).

Besides the demand-pull measures, the Chinese government introduced supply-push measures in 2017, which include as a key tool, the New Energy Vehicle (NEV) policy. This came as a result of the demand-pull's increasing controversy and burden to the fiscal expenditure, which together with progress in the USA's ZEV and Europe's car emission caps, influenced China's introduction of this supply-push measure (Ou et al., 2019). The measure encourages suppliers of vehicles to sell more electric vehicles such as BEVs, PHEVs and HFCs. It sets requirements for the number of NEVs sold in 2019 and 2020, as well as targets for 2021 to 2025 (Hardman et al., 2018). Table 2.3 illustrates differences between Chinese and USA government mandates.

Table 2.3: China's NEV vs US's ZEV mandate (Hardman et al., 2018:03)

	California ZEV Program	China NEV Regulation
Regulated OEMs	OEMs that sell more than 20,000 vehicles per year	OEMs that sell more than 30,000 vehicles per year.
Credits[1]	7% in 2019 9.5% in 2020 7-12% by 2025	10% in 2019 12% in 2020 20% in 2025
Can credits be saved for future years?	Yes, with limitations	No, with the exception of 2019 to 2020
Technological Specificity	Certian portions of requirement must be pure ZEV (BEV or FCV)	Any of the three drivetrains can be used for compliance (no maximum)
Credits per vehicle sold	0.4 to 4	1 to 6

What Figure 2.3 shows is clear similarity between Chinese NEV and United States ZEV mandates in terms of scope. The Chinese mandate is still newer and more generous than the US's mandate in terms of size, e.g. 0.4-4 credits per car sold in the USA, as opposed to 1-6 credits per vehicle sold in China. A key feature of both tools however is that, they are designed to encourage innovation among automakers and to internally subsidise electric vehicles, hence shifting the burden away from government (Hardman et al., 2018 and Ou et al., 2019). This is a new tool in China, whose victory is yet to be determined. Using California's experience with its older ZEV mandate, some predictions can be made about the future implications of China's NEV Scheme (Hardman et al., 2018).

2.3.3.2. Asia-Pacific biofuel experiences

Numerous governments in Asia-pacific according to Gheewala, Damen and Shi, (2013) support biofuels due to many benefits these fuels possess. Elder and Hayashi (2018) noted that in the late 2000s, many Asian countries had high expectations from biofuels. These included perceived benefits on improved energy security, reduced greenhouse gas (GHG) emissions, rural development, industry development, exports and employment creation. In Asia Insight (2018), a senior researcher from Japan's Institute of Energy Economics was recorded as saying that 'Biofuels only play a bridge role, until 'new energy vehicles' become widespread'. About ten years ago, through funding from USAID, the International Resources Group (IRG) (2009) studied seven Asian countries including China, India, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam as they either produced or planned to produce significant amounts of biofuels in the future. Support measures adopted in each of these countries, are discussed in the following paragraphs.

In 2006, the Philippines government developed a Biofuels Act, which mandated a steady introduction and rise of biofuels from 1% in 2006 to about 10% in 2012 and beyond. The following incentives would support the uptake:

- ❒ Zero specific tax per litre on local and imported biofuels,
- ❒ The sale of raw materials used in the production of biofuels shall be value added tax (VAT) free,
- ❒ All water effluents considered as "re-useable" are exempt from wastewater charges,
- ❒ Government financial institutions shall, in accordance with their respective charters or applicable laws, accord high priority to extend financial support (ERIA, 2014).

ERIA (2014) also noted how Thailand set 2008 and 2011 targets, mandating a 5% blending of ethanol with conventional fuels. Government used preferential taxation as a tool to encourage consumer purchase of this blend and conducted research on the cassava plant, with the aim of improving the yield for ethanol production. Indonesia on the other hand, took a related position in 2006, with government developing policy framework, which set an initial blending target of 2%, growing to 5% in 2016. Using palm oil and cassava plants as feedstock, government allocated hectares of land for plantation purposes and supported the programme through specific incentives as follows:

- ❒ Nominal stamp duties,
- ❒ Agreement with 50 countries on the avoidance of double taxation,
- ❒ Relief from import duties,
- ❒ Investment tax allowance in the form of taxable income reduction of up to 30% of the realised investment, spread over six years,
- ❒ Accelerated depreciation and amortisation,
- ❒ Loss carried forward facility for a period of no more than 10 years,
- ❒ 10% income tax on dividends, possibly lower if stipulated in the provision of an existing applicable tax treaty,
- ❒ Selected strategic goods exempt from value-added tax (ERIA, 2014).

In 2006, the government of India mandated 5% blending of ethanol with petrol and biodiesel blend to reach about 20% blend in 2020. The ethanol target would increase to 10% in the third phase. Government also offered sugar millers preferential interest loans to build biofuel production facilities with sugar cane and Jatropha earmarked as preferred feedstock (USDA, 2017; ERIA, 2014).

2.3.3.3. Asia- Pacific CNG experiences

In the Asian countries, there have been many drivers towards CNG use in transportation. These range from air quality improvement, energy security, CO_2 emission reduction, international pressure, e.g. petrol import sanctions as in the case of Iran, availability of gas resource. Countries studied by Ogunlowo, Bristow and Sohail (2015) included India, Pakistan and Iran. As noted from global NGV Statistics by IANGV (2018), these three countries appear in the global top ten list of countries with more NGVs. They excluded China and Thailand, the Asian countries that also appear in the top ten list of global countries with the most NGVs. A variety of financial and non-financial support tools adopted in these countries range from preferential tax schemes, incentives for establishing charging infrastructure, incentives for buyers of NGVs and incentives in the form of easy access into the cities such as those used in India's Delhi (Stratas Advisors, 2016). As such, they target the demand and supply side as depicted in Figure 2.5. The most common tools used are monetary-related support measures offered by both government and industry. These authors, however, warn against over-reliance on government incentives, particularly the subsidies, since their removal might result in the collapse of the market as happened in New Zealand.

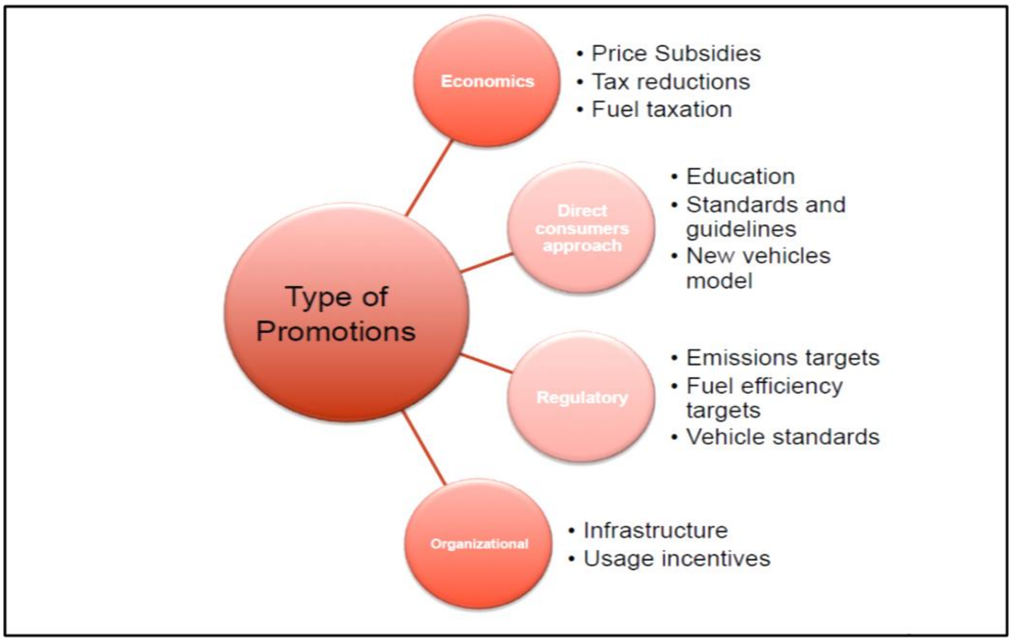

Figure 2.5: Tools to promote CNG in Transportation (Stratas Advisors, 2016)

Two major incentives in Pakistan, according to Ogunlowo et al. (2015), included custom duty and tax exemptions to the operators of retail fuel stations. These authors proposed that a higher price differential between CNG and conventional fuels is crucial for increased uptake of the former. Similar to Argentina and Brazil discussed in the next sub-section, Pakistan's CNG success is related to the country's CNG conveyance infrastructure (Ogunlowo et al., 2015).

Khalaj (2013) noted that in Iran (the world's leading NGV country), a government investment programme helped stimulate the adoption of dual-fuel vehicles into the market. In turn, this significantly enhanced the use of CNG, hence offsetting the negative effects associated with fuel import sanctions imposed on this country. Environmental drivers are often cited with the main driver appearing to be energy security, following the US and EU petrol fuel import sanctions. Development of NGVs is nonetheless experiencing numerous challenges, which include, among others, high capital investments to build charging infrastructures as well as relatively higher retail prices for the gas (Khalaj, 2013).

2.3.4. Latin America's experiences (Brazil as a reference country)

Like countries in North America, Asia-Pacific and the European Union, the southern regions of America have adopted more than one type of green transportation mode/ technology and fuels. Using Brazil as a case study, the sub-sections below describe the South American experience with respect to promoting the use of biological fuels and compressed natural gases in their transportation systems. As noted in Baran et al (2013), one of the major hindrances to the successful uptake of electrically powered automobiles in Brazil is the highly subsidised biofuels programme as discussed in the following sub-section.

2.3.4.1. Biofuel use in transport

As the world second producer of biofuels after the USA, Brazilians blend this fuel with conventional gasoline, producing a blend called gasohol. Government set the blending content to between 18 and 27.5% v/v, depending on the market forces (Belincanta et al., 2016). Ethanol's success in Brazil according to Cavalcanti, Szklo, Machado and Arouca (2011) is largely due to a heavily incentivised production and consumption programme. This has been in effect since 2013, as a response to a need to equalise low international prices of sugar and ethanol's inability to compete with petrol, whose price had been kept low deliberately (Soto and Teixeira, 2016; Addington, 2017). When ethanol was introduced, it was priced around 12 centavos ($0.04) costing less per litre when compared with conventional fuels.

The promotion of alternative fuels in Brazil seems to have occurred at the expense of revenue collection, although an increase in greener vehicles into the country's road fleet could lead to increased revenue. In their study of the Brazilian taxation of ethanol, Cavalcanti et al. (2011) came to conclusion that Government can indeed recover part of the lost revenue with no impact on the country's capability. This could be done by ending the exemption, reducing the supply and demand for biofuels, thus encouraging this country to procure conventional fuels from abroad, while distributing more sugar to the external market. In response to the challenges of forgone revenues from such exemptions, the government of Brazil introduced the "RenovaBio" law. This was intended to stimulate the production of biofuels such as ethanol, biodiesel and biogas, and provide fiscal incentives and targets for the reduction of emissions (Cavalcanti et al., 2011).

2.3.4.2. NGVs in Latin America

Brazil’s use of natural gas dates back to the mid-1990s and as such is a nascent sector in this country (NGV Global Knowledgebase, 2009). Government authorised its use only in metropolitan buses and certain vehicles such as converted taxicabs or commercial medium duty vehicles. Like the three Asian countries studied by Ogunlowo et al. (2015), Brazil and Argentina appear in the top ten list of global countries with the highest number of NGVs reported in the IANGV (2018) statistics report. Similar to the “Blue Corridors” project between Russia and other EU member countries, South America’s “Blue Corridors” project seems to have contributed to speeding up natural gas uptake in this region. These are corridors, which according to the NGV Global Knowledgebase (2009), connect major cities in Latin America. In Europe, these corridors are claimed to have driven the uptake of natural gas vehicles (Fevre, 2019).

Similar to Pakistan (see preceding sub-section), Argentina and Brazil made national interest a priority ahead of the Blue Corridor regional infrastructure initiative. The Argentina success is also partly due to their advanced natural gas networks, with Brazil’s network, according to Ogunlowo et al. (2015), constructed long before the announcement of the Blue Corridor initiative. Argentina and Brazil are the two largest markets for gas in Latin America, which accounted for around four million NGVs in 2017 (Fevre, 2019). This is equivalent to about 9.5% of the total vehicle population in Argentina and 2.2% in Brazil. This is, however, a huge decline given that these countries (as reported in Panorama, 2006) were once world leaders, with Argentina having the largest the NGV fleet (about 21% of its total fleet) in 2006.

Policy developments alongside the demand and supply side financial and non-financial incentives, as discussed in preceding sections, have without doubt led to the world’s current developments in the leading green transportation countries. Regionally, developments in Africa have been slow, but promising. The following section focuses on Africa.

2.4. TRANSPORT GREENING IN AFRICA

The Sub-Saharan African (SSA) transport sector depends solely on conventional fuels, thus creating numerous socio-economic challenges in the region. In its World Energy Outlook, the International Energy Agency (2019) presented a special report on the status quo of energy in Africa. The report revealed that the Sub-Saharan Africa (SSA) region has the world’s lowest level of per capita car ownership, comprising only about 6.6 million passenger cars in cities. These cars represent around 80% of the region’s total car stock. The region however has a larger stock of about 16 million fossil fuel powered two/three-wheelers, with rural areas accounting for over half of the current stock of these wheelers. The majority of these wheelers, according to the IEA special report, are cheap second-hand motorcycles imported from Asia. Also, the majority of cars (about 80%) used for personnel transportation, are second-hand machines, imported largely from Japan and Europe. Currently, more than half of African countries do not impose any restrictions on second-hand vehicle imports; of those with restrictions, half apply age limits of between 8-15 years. The biggest challenge with these vehicles is that they are brought into a region that does not have strict standards for the quality of fuel and vehicles used in the market. For new cars, only Nigeria, according to the International Energy Agency (2019) report, has adopted Euro 3 standard (a standard that became obsolete in Europe almost two decades ago). The average fuel economy of cars on the road in sub-Saharan Africa is 8.4 litres per 100 kilometres (L/100 km). The East African Community is leading the way with fuel quality specifications as it harmonised fuel quality standards in 2016, setting sulphur limits for gasoline of 150 parts per million (ppm) and for diesel of 50 ppm (International Energy Agency, 2019).

Energy issues in Sub-Saharan Africa (SSA) relate to lack of fuel security of supply, high costs associated with fuel importation and serious pollution in major cities, similar to those experienced in China's and India's cities and in California (Hug and Schwela, 2012). Governments in this region have a tendency to provide high subsidies to the fossil fuel industry, hence negatively affecting decisions towards the development and use of alternative fuels (Hill, Mutiso and Shirley, 2018). In the meantime, most SSA countries have abundant sources of renewable energy in the form of solar, geothermal and hydro energy, something which places them at an advantage when it comes to alternative energy usage in the transport sector. The International Energy Agency (2019) noted that Africa has the richest solar resources on the planet, is home to more than 40% of global gas and is endowed with major reserves of minerals such as cobalt, uranium, platinum that are crucial for clean energy technologies. This means that the continent possesses key ingredients for global energy transitions. Challenges relate to, among others, limited capacity and lack of resources to harness these abundant energy resources. With the strong global trends in electric vehicle roll-out, the SSA countries, according to Hill et al. (2018), stand a chance to actively explore and introduce less costly alternative energy, hence minimising the reality of being trapped into too much reliance on fuels obtained from abroad. This, however, requires (as noted in the major green transportation countries discussed in the previous sections) clear fiscal policy instruments to harness alternative energy for use in fuelling the transport industry. Like anywhere in the world, this is problematic for SSA countries given the many competing priorities for limited government funding as noted by Hill et al. (2018).

Table 2.4 shows some countries in SSA made progress nonetheless in rolling out biofuels as noted in the report by the International Energy Agency (2019). These countries announced mandates to support biofuel use in the transport industry, with the most popular mandates being ethanol blending rates of 5% to 10% (i.e. E5 and E10). In 2009 the Mozambican government published a national biofuels policy and strategy to contribute to energy security and sustainable socio-economic development, especially in the rural areas (Schut, Slingerland and Locke, 2010). This called for the introduction of compulsory 10% blending of ethanol (E10) with petrol (gasoline) and 5% blending of biodiesel (B5) with conventional diesel. By 2011, Zimbabwe, on the other hand, had already introduced a 10% mandatory blending of fossil petrol with bioethanol, leading to the new grade-E15 adoption in the market (Mukonza, not dated). In Malawi, mandatory blending of gasoline with bioethanol from sugarcane molasses for the transport sector occurred as early as 1982 (Kalowekamo, 2013). This grade, according to Mukonza (not dated) is for both the domestic and export markets to the East African counties, with smaller amounts being sent to Mozambique, Zambia and Botswana.

Table 2.4: Biofuel mandates in select SSA countries (IEA, 2019: 96)

Country	Mandate	Target	Potential from agricultural residues
Angola	Ethanol 10		11%
Ethiopia	Ethanol 5	Ethanol 10	n.a.
Ghana		Replace 10% of fossil fuels by 2020 and 20% by 2030	n.a.
Kenya	Ethanol 10	Ethanol 5, Ethanol 10	5%
Malawi	Ethanol 10		n.a.
Mozambique	Ethanol 10		1%
Nigeria	Biodiesel/Ethanol 2	Ethanol 10	n.a.
South Africa	Ethanol 2, Ethanol 10		n.a.
Sudan	Ethanol 5		n.a.
Uganda		Ethanol 20	n.a.
Zimbabwe	Ethanol 10	Ethanol 15, Ethanol 20	n.a.
Zambia		Ethanol 10	n.a.

In 2019 biofuels still accounted for less than 0.1% of transport energy used in Africa. The International Energy Agency (2019) noted that South Africa's and Nigeria's contribution in 2018 accounted for about 5% market growth in biofuel use in the region. The evolution of the biofuels market in the Africa continent takes into account the potential supply of second generation feedstock from agricultural residues in key African countries.

In addition to biofuels, some countries in the region demonstrate an increased interest in the use of Natural Gas Vehicles (NGVs). Nigeria (one of the world leading countries in the export of oil and gas) has, according to Ogunlowo et al. (2016), started utilising flue gas, which for many years, it was losing through flaring. As a way of addressing energy security of supply, and to eliminate the need for flaring, this country implemented projects in 1990, which aimed at compressing and using this gas in automobiles. Since then, this country has introduced into the market about 3798 NGVs and eight gas-fuelling stations, with ten more fuelling stations, according to the NGV Journal (2020), under construction or projected for construction. With the exception of Egypt, this is the biggest number of NGVs compared to the volumes reported in other African countries including South Africa. The NGV Journal (2020) recorded a total of 215 NGVs and four fuelling stations in Algeria, 55 NGVs and one fuelling station in Tanzania and 1380 NGVs and five refuelling stations in Mozambique. The largest number of NGVs is found in Egypt, where a total of over 280000 NGVs, 187 fuelling stations and 72 conversion centres were reported in the NGV Global News (2019). Egypt's roll-out of NGVs has been speeded up by political leadership and the Government's *Towards Natural Gas* programme targeting the conversion of mass automobiles to use compressed natural gas (NGV Global News, 2019). Initiated by Government and the industry players, the plan includes provision of new support and funding mechanisms for the construction of supply facilities and the conversion of fossil fuel powered vehicles to natural gas. Drivers who want to convert their vehicles, receive concessions from participating oil companies, as a way of reducing conversion costs. The companies offer easy payment facilities to car drivers who want to transfer their cars through instalment systems without advance or interest and with simplified contracting procedures.

This sub-section has discussed literature on transport greening support interventions in Africa, largely the SSA region. Literature on interventions in South Africa is discussed in the next section. The Southern African Institute on International Affairs (2013) wrote a paper which contextualised green economy development in the Brazil, Russia, India, China and South Africa (BRICS) member countries. The paper highlighted important steps that individual countries, including South Africa, have taken to establish systems to support green economy development. The study compared policy outcomes implemented in these regions, hence producing a summary of policy approaches to developing a green economy. It should be noted that, individually, South Africa has conducted research and produced a number of research documents targeted at transport greening policies. Some of these research studies are discussed in the following section.

2.5. GREEN TRANSPORT POLICY RESEARCH IN SOUTH AFRICA

Various research in the transport greening field has been conducted in South Africa, some of which was introduced in sub-section 1.5.10. These research studies explore aspects of transport greening and contribute to knowledge about sustainable transport in this country. One study by Vanderschuren and Jobanputra on fuel efficiency options, way back in 2004, may appear old in the context of this thesis, but the options discussed for fuel efficiency improvements in South Africa's transport sector are still applicable. A summary of results is presented in Figure 2.6 showing efficiency improvements per option. The writers included alternative fuels and vehicles, classifying their analysis into *fuel efficiency, fuel displacement, fiscal measures and travel demand management.* Figure 2.6 depicts diesel followed by congestion charging as best options for improved fuel economy in transport. It can be deduced that policy makers relying on such conclusions would promote the options that demonstrate relatively higher efficiencies. Fuel cells and electric vehicles in the

Vanderschuren and Jobanputra study received the lowest efficiency ratings at 0 and 2% respectively, implying they were not highly regarded in comparison to the present.

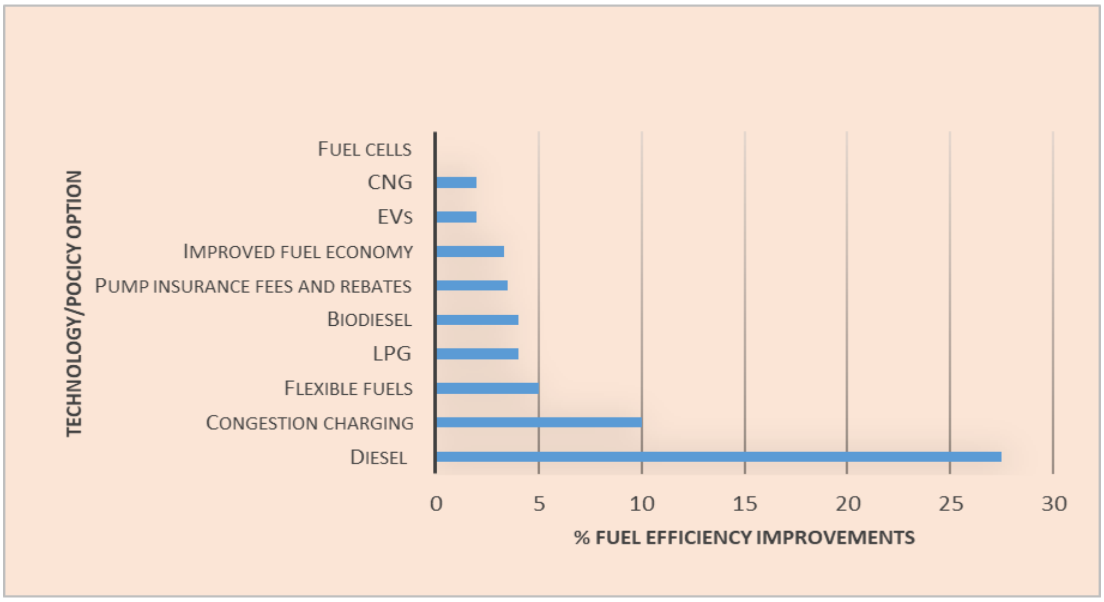

Figure 2.6: Fuel efficiency options for South Africa (Adapted by author from Vanderschuren and Jobanputra, 2004)

Ten years after the Vanderschuren and Jobanputra study, the National Department of Environment Affairs (DEA, 2014) conducted research to understand the status of South Africa’s Greenhouse Gas (GHG) emissions and to identify mitigation options. While this research is also old in the context of this thesis, the mitigation options identified are however still applicable. DEA’s research culminated in a series of reports, including a report on the transport sector’s contribution to the country’s GHG emission problem, as well as mitigation options for this industry sector.

By 2050, the increase in emissions was projected to be almost 300%, with the major culprits being passenger vehicles as well as low, medium and heavy delivery vehicles. DEA (2014) identified modal shift, demand reduction measures, improved vehicle technologies, more efficient operations and the introduction of alternative low carbon fuels as potential mitigating options. These are depicted in Figure 2.7. The options suggested in DEA’s report do not differ much from those suggested by Vanderschuren and Jobanputra (2004) study of potential fuel efficient measures. By virtue of its definition, the phrase “fuel efficiency” has implications for the social, economic and environmental pillars. The difference between the two studies was mainly in the weighting given to various options. Also the 2004 study did not have an environmental bias, but focused on determining efficiency capabilities of various transportation technologies towards improved fuel efficiencies.

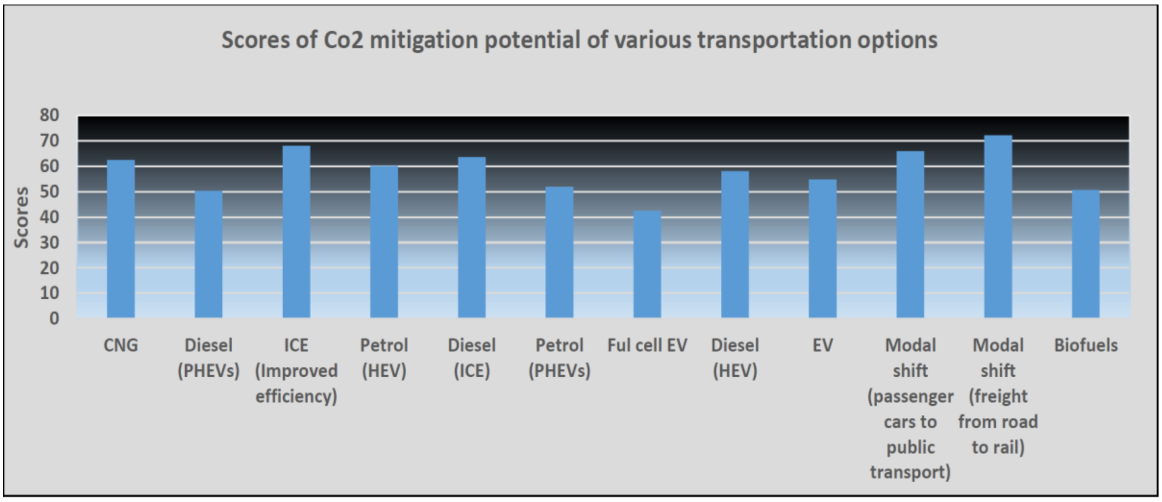

Figure 2.7: GHG Mitigation potential of various transportation options (by author from DEA's GHG Mitigation Potential Report, 2014)

While the analysis provided in the DEA (2014) greenhouse gas mitigation report identified potential mitigation initiatives, it did not single out any particular transport greening technology. Rather it provided an analysis of potential mitigating effects of each technology from 2010 through to 2050. These measures, however, are biased towards the "environmental pillar" of sustainable development, with the main driver behind the suggested measures being climate change mitigation. There seems to be a link here with what happened in the European Union, where the latest transport greening initiatives seem to have been driven largely by the desire to reduce carbon dioxide emission as noted in Nesbit et al. (2016).

In the Department of Environmental Affairs (2014) study, while diesel fuel obtained a reasonable score, it was not the highest score. Instead, modal shift from passenger vehicles to public transport, modal shift from freight to rail and improved efficiencies from internal combustion petrol engines, received relatively higher scores. Fuel cells in both studies received the lowest scores. The drivers were different, one being fuel efficiency improvement and the other being GHG mitigation. The challenge with such studies is bias towards a particular pillar of sustainable development. This makes it very difficult for policy makers in the transport greening arena, especially when the studies arrive at conclusions on opposite ends of the spectrum, in terms of recommending potential options.

South Africa's transition to a green economy is linked to numerous policy frameworks falling within the mandates of various government departments. Flaws noted by critics include, amongst others, lack of interdepartmental harmony (South African Cities Network et al., 2015). Regulatory uncertainty around fuel taxation as well as lack of access to municipal waste are some of the weaknesses highlighted in the 2015 biogas report by the Department of Environmental Affairs, South African National Energy Development Institute and UKaid (2015). Vosper and Mercure (2016) analysed the effectiveness of South Africa's Carbon

Dioxide (CO_2) levy in changing the behaviour of private vehicle consumers. This is an incentive mechanism imposed on the purchase of new private passenger vehicles. This “punitive tax”, according to Vosper and Mercure (2016), does not seem to have altered behaviour or reduced emissions of this greenhouse gas.

While the Department of Transport, according to ERC (2013), supports electro-mobility, it does not prioritise it. ERC also noted that, despite the existence of the EV roadmap in South Africa, the Department of Trade and Industry’s automobile incentive scheme, makes no specific reference to EVs. The Department of Environmental Affairs does however include electric vehicles in the flagship programmes aimed at encouraging new energy efficient-vehicle technologies (Department of Environmental Affairs, 2011). ERC (2013) noted that in rolling out electric vehicles, Government adopts:

> … a ‘living lab’ approach which will allow the country to keep abreast of developments, be ready to move in the direction of greater e-mobility but not to invest too heavily in this area while there is significant market risk and uncertainty (ERC, 2013:2).

The ERC’s conclusion aligns with a statement made by a senior government official in the Department of Energy. Mkhize (2015) stated, in a biogas/compressed natural gas seminar/conference in Johannesburg that, Government’s delay in making legislative provisions for direct use of gas in transport, is to allow the industry to find its feet. The statement continued to say that only when a need for *‘enabling’* legislative provisions arises, would Government intervene to support industry efforts. The Parliamentary Monitoring Group (2014) recorded minutes of the meeting on the gas sector, between the Department of Energy, National Energy Regulator of South Africa, PetroSA and SASOL and the Deputy Minister of Energy. This meeting confirmed that the transport sector provides one of the immediate demands for gas, where such gas is a substitute for conventional transport fuels, and is always priced 20-30% below the petrol price. This therefore implies that the South African Government does recognise the potential role of gas in transport. Despite the lack of legislative framework enabling direct use of gas in transport, developments in transport sector greening in South Africa have nonetheless continued, as discussed in the preceding chapter.

The Academy of Science of South Africa (ASSAF, 2014) has provided a list of possible green transport solutions for South Africa (although these solutions had no implementation constraints). The solutions include hybrid or electric cars and buses, bus retrofitting to use hybrid fuels (gas), electric bikes, biodiesel, gas fuel technology and hydrogen fuel cells. This resembles findings in a study conducted two years later by the National Department of Trade and Industry (**the dti,** 2016). This department commissioned a study that analysed the status quo of policy environment with respect to transport sector greening in South

Africa. The study provided a high-level review of transport sector policies, as well as a framework for policy direction with respect to promoting green technology uptake. In summary, the policy findings of this study are portrayed in Figure 2.8. It examined three policy instruments (taxation, subsidies and regulations). As alluded to in ERIA (2014), NGV Global News (2018), Hardman et al. (2018) and Slowik, et al (2019), these types of policy instruments have been and continue to be used internationally to support the transition to greener mobility. Figure 2.8 shows that throughout the transportation value chain, legislative and policy provisions for transport greening are sparse in South Africa. Instead, more provisions (including taxation decrees, subsidies and regulations) target the conventional fossil fuel-based transportation modes throughout the value chain, from fuel supply right through to end users.

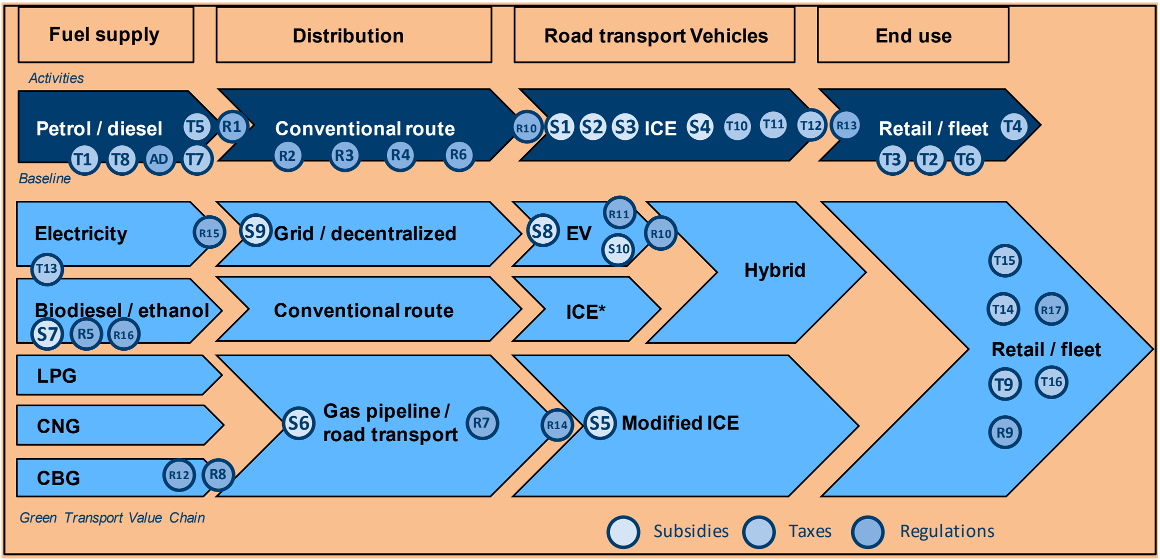

Figure 2.8: Findings of **the dti** study (**the dti**, 2016)

Debates over the ‘less’ vs the ‘more’ of the policy provisions when comparing traditional with green transportation routes need to be approached carefully. In the context of ‘self-regulation’ discussed in a 2015 report by the Organisation for Economic Co-operation and Development (OECD), the absence of regulatory frameworks is sometimes described as the better than when there is too much government intervention. Contrary to this view, the role of government intervention was praised in Chapter 1, with reference to Rietveld and Stough (2006) as well as the World Bank Public-Private-Partnership Legal Resource Center (2019). These writers viewed government intervention as important in driving technological change towards sustainable outcomes, calling for use of taxation policies and public-private partnerships in driving the transition towards a greener economy. The implication of **the dti** study findings in the context of these contradictory positions is, therefore, debatable. While **the dti** study provided useful insight into existing policy gaps in South Africa’s transport greening agenda, it was not designed to be an academic report. It was lacking in detail and only provided a quick analysis and policy summary of the status quo.

Some principles emanating from studies discussed in this section, including Vanderschuren and Jobanputra (2004), ERC (2013), DEA (2014), ASSAF (2014), **the dti** (2016) and others, are incorporated into South Africa's Green Transport Strategy (GTS 2018-2050) produced by the Department of Transport (2018). This strategy is only briefly alluded to in this chapter, but is discussed in detail later in the thesis. The research findings in this thesis build on these studies, with more detailed and critical examination and presentation of policy, regulatory and legislative frameworks relating to green transportation in South Africa.

2.6. CONCLUSION

This chapter has reviewed literature on green transportation focusing on the existing worldviews as well as approaches to policy, regulatory and legislative frameworks. The chapter introduced the concepts of green transportation, explored various definitions and described the challenges associated with the absence of a universal definition. Green transportation is either defined from an environmental, economic or social perspective, or from all three of these sustainable development pillars. Some definitions add reductionist approaches, stressing the need to avoid travel as was the case with the *'avoid, shift and improve'* (A-S-I) model. It was argued that this model, together with the green transportation pyramid, are an expression of views around what stakeholders ought to do to bring about transport greening. The concept of transport greening was also described in the context of non-motorised transportation such as walking and cycling, carpooling, use of public transportation, use of alternative vehicles and fuels. The chapter further provided views on how governments are performing in this area – as enablers while also being constrained. The role of developed countries, especially those in the European Union that have influenced transport greening decisions of developing countries, was also highlighted.

In addition to general views on the world responses to green transportation, the chapter also examined policy and legislative frameworks developed and implemented in North America, South America, Asia Pacific, Latin America and Africa. The chapter alluded to the critical role of governments in developing and implementing enabling policy and regulatory frameworks. Such frameworks include various forms of incentive mechanisms targeting the demand and supply of transport greening goods and services. Policy drivers differ, however, with the European Union driven mainly by energy security and climate change concerns, specifically a desire to reduce CO_2 emissions, while in the US, especially in cities like California, air quality concerns seem to have been the main drivers. In Asia-Pacific, a need to reduce pollution in major cities as well as pursuit for energy independence and poverty alleviation, seem to have been some of the major drivers. Policy drivers in Africa highlight a combination of resource availability, as was the case with Nigeria and a need to reduce too much reliance on fuel imports. Literature on South Africa's approaches highlights lack of coordination and a fragmented approach as the main deficiencies of this country's transport greening system. South Africa is deemed to have good policy and legislative frameworks, with the major issue however being lack of implementation of these frameworks.

While the chapter has examined perspectives on transport sector greening, the lack of a universal definition of green transportation, as well as the existence of other synonyms like ecomobility, sustainable transport and alternative transport, have complicated the literature review process. The chapter also did not examine country-by-country policy, regulatory and legislative frameworks. This was an attempt to reduce the scope of the research given the number of countries within this region. Many countries within the EU have indeed developed and implemented a variety of initiatives in country policy, regulatory and legislative framework in addition to the directives applicable to all. This research limited its scope to the provisions and role of the EU directives in facilitating transport greening within this region. While this chapter reviewed general literature on perspectives and policy approaches to transport greening, the next chapter provides a review of literature on conceptual frameworks. These frameworks were used in this research to explain and describe government responses to green transportation. The review therefore seeks to put in theoretical context, reasons behind certain transport greening choices made by South Africa.

CHAPTER THREE

THEORETICAL FRAMEWORK REVIEW

3.1. INTRODUCTION

The multi-disciplinary nature of the phrase ‘green economy’ invites a variety of theoretical frameworks to guide interpretation, in this case, the interpretation of the South African government’s responses to green transportation. While theory, according to Thomas (2017) is not commonly defined across or within different disciplines, Creswell (2009) noted that it might appear in a research study in different ways such as argument or discussion. In either case, it serves to explain or describe the reality, providing concepts to name what has been observed (Perrin (2014). It is used to match unrelated findings to understand commonalities and construct abstract understandings of society and behaviour. Thomas (2017) argued that often scholars do not agree on both the value as well as practical application of theory. Various definitions provided in the Merriam Webster Dictionary (2020) infer that theory means the following:

- ❒ an ideal or hypothetical set of facts, principles, or circumstances – often used in the phrase in theory,
- ❒ a hypothesis assumed for the sake of argument or investigation,
- ❒ a plausible or scientifically acceptable general principle or body of principles offered to explain phenomena,
- ❒ the general or abstract principles of a body of fact, a science, or an art abstract thought,
- ❒ the analysis of a set of facts in their relation to one another (Merriam Webster Dictionary, 2020).

The University of Southern California (2020) theories allow researchers to evolve intellectually, from simply describing a phenomenon being observed to generalising about various aspects of that phenomenon. They are designed to challenge and extend the knowledge, explain the nature and meaning of the phenomenon, in a manner that enhances understanding and effective use of the knowledge in a more informed manner. Theories help understand what needs to be done, guiding the research process and allowing researchers to make links between the real life and abstract/ thought statements (Sunday, not dated). Defining theory within the context of sociology, Gabriel (2008) further stated that theories help to make predictions, to challenge and at times, expand the existing knowledge base. Using the 2003 Longman Dictionary of Contemporary English, De Benetti (2009) defined the word “theory” as:

> An idea or set of ideas that is intended to explain something about life or the world, especially an idea that has not been proved to be true. General principles and ideas about a subject; or opinion that someone thinks is true but for which they have no proof (De Benetti, 2009:01).

This chapter provides a review of theoretical frameworks that were used in this thesis to guide the interpretation of study results. Four theoretical frameworks used in this research and introduced in this chapter include: interventionist theories, sustainability theories, systems theories as well as globalisation theories. The relationship between these frameworks, as well as their relevance, is also presented. The chapter is concluded with a summary of key discussion points.

3.2. INTERVENTIONIST THEORIES

Interventionist theories relate to Keynesianism world-views discussed in Chapter Two. They provide views that contradict views contained in neoclassical and neoliberal economic theories. The later theories, as discussed in Mohr, Fourie and Associates (2015), are based on Adam Smith's *'invisible hand"* world views, which call for privatisation, self-regulation, improved management of the public sector and liberalisation of financial markets as well as austerity/reduced state spending. The previous two chapters discussed how deficiencies of conventional approaches to transportation encouraged governments to intervene, in order to encourage investments in green transportation. Reference was made to Rietveld and Stough (2006) as well as the World Bank Public-Private-Partnership Legal Resource Center (2019), who expressed the paramount role that government intervention can play in driving technological change towards sustainable outcomes. As discussed in the previous chapter, the demand pull and supply-push measures which assisted China speedup the roll-out of plugged in electric vehicles (PEVs) in the market, are documented in Yingqun (2017), Ou et al. (2019) and Hardman et al. (2018). The use of supply targeting tools in California have been used successfully and are also recorded in various literature including Forbes Media LLC. (2017), Center for Climate and Energy Solutions (2019) and others, as discussed in the previous chapters. A variety of financial and non-financial support tools (e.g. taxation schemes, subsidies and mandates) adopted in other Asia-pacific, Latin America, European Union and North American countries, are also highlighted in various studies introduced in the previous chapters. These include, among others, Stratas Advisors (2016), Ogunlowo et al. (2015), NGV America (2020), US Department of Energy (2020), Guan and Oh (2018).

What is discussed in the preceding paragraph, are forms of government interventions which were initiated to address specific problems of countries. What is meant by intervention can be found in the work of Argyris (1970), who argued that the concept simply refers to entering into an ongoing system of relationship between persons, groups or objects with the purpose of helping them. While government interventionist approaches are often criticised as discussed in the previous chapter, some writers, notable the WebFinance Inc. (2017), support it, especially when the said intervention seeks to address specific injustices. Most economists, according to Schiller, Bruun and Kenworthy (2010), agree that costs that were previously externalised should now be internalised, through the use of many command and control oriented tools. As noted in Nesbit et al. (2016), the early responses to transport greening in the 1970s European Union, sought to address safety, oil crisis and market protection objectives, with the later responses addressing environmental challenges. Also, fuel economy regulations, were first implemented in the USA in the 1970s to reduce vulnerability to the price volatility of oil import (Miller and Facanha, 2014). These countries were trying to address negative externalities, which required specific policy interventions, in addition to the “invisible hand" of market forces.

Applied within physical sciences, Woodward (2009) provided a rather different interpretation of intervention, explained within the cause and effect relationship using the words, “manipulator” and “manipulated”. Perhaps a more humanistic account of interventionist described by this author relates to his argument on the existence of proof that intervention/ manipulation facilitates causal behavioural changes in humans in comparison with passive observation. This includes the concept of voluntary actions, which tend to lead to particular changes. All voluntary actions, according to this author, do not, however, qualify as intervention. Put differently and citing Woodward’s work, Reutlinger (2013) noted that the key idea relates to how B responds when something is done to A that makes B respond in a particular manner. The intervention, according to this writer therefore relates to the way in which the cause (and only the cause) is manipulated. The condition for this relationship to work is that all other variables should be held constant. Many reasons exist why an intervention might be required, and these range from an effort to help a person or group of persons, or entity, to make their own decisions right through to manipulating them to follow one’s wishes. Argyris (1970) laid down specific requirements for any intervention to be effective. One such requirement is sustainability of the intervention. This means that once the interventionist has left, the system should not die, but continue sustaining itself for as long as its existence is still relevant and justifiable. If, for example, the intervention involves the imposition of tax to discourage certain behaviour, the removal of this behaviour-targeting intervention should not lead to the very same behaviour reverting to the previous status quo prior to imposition of the tax.

Interventionist theories were deemed applicable in the context of South Africa, given the existence of many players, who look up to Government for the provision of various services including, among others, fiscal incentives to fund public transportation, and policies to enable investments in the sector. There are two clients in the case of the South African Government’s situation: the transport system users and the system providers (i.e. the demand and supply dynamics). In this case, Government would be intervening in relationships that already exist between these participants. Government makes laws, charges tax and makes subsidies available. It is an institution that is required to create a conducive environment for these clients to operate effectively. While, as noted in Mohr, Fourie and Associates (2015), debates exist on the effectiveness of the state, these writers acknowledge its role due to possible failures of market systems. Mara and Dias (2002), among others, rejected the notion that a free enterprise system can resolve environmental challenges, therefore arguing for more increased state intervention. The use of these theories in this research addresses the question of what interventions the Government of South Africa has implemented, and to what extent these interventions have been effective.

There are similarities between interventionist theories and other conceptual frameworks, including sustainable development theories discussed in the next sub-section. The relationship between these theories is further illustrated in Figure 3.5 of this chapter.

3.3. SUSTAINABILITY DEVELOPMENT THEORIES

The importance of discussing sustainable development principles here can be traced from the many drivers to transport sector greening at international level, as per the experiences of various leading green transportation countries discussed in Chapter Two. Understanding these principles was deemed crucial in understanding the rationale behind the green transport policy provisions adopted by South Africa's policy makers. At a global level, sustainable development, according to Kurian and Bartlet (2010), does include similar issues among various players. Developing and industrialised nations also interpret it differently. These writers used this phrase within the context of environmentalism where they refer to three types of environmentalism: ecological, economic and social environmentalism. At the same time, these writers noted how these environmentalisms clash with each other. Leberge (2015) reviewed a book Enders and Remig that presents thirteen essays on theoretical discussions around sustainability, with findings not necessarily aimed at drafting a detailed theory of sustainability. In presenting the different ways in which writers of these essays define 'sustainability' and 'sustainable development', Leberge (2015) noted the following:

- A need to recognise and accept the social pillar of these concepts;
- A need to define what is meant by a globally feasible, stable and realistic way of living;
- Concepts are about trying to identify and address many life challenges that cut across various disciplines;
- A detailed articulation of sustainability, where this concept is further described as a "normative category" that "triggers a specific complex of integration problems"; and
- At the centre of every chapter, theory itself seems to be the neglected dimension of most studies in sustainability, although its real importance remains debatable for some experts (Leberge, 2015).

Wallis and Valentinov (2017) regarded sustainability as a key concept, critical in helping humans comprehend and improve their societies. With its origin in the 1970s, it is a concept that calls the world to appreciate existing connections between social, economic and environmental phenomena (Allen and Ervin, 2007 and WCED, 1987). Different versions of a sustainable development model exist, ranging from a three-legged chair, three circles and the nested dependencies model as portrayed in Figure 3.1. Willard (2010) explained that the three-legged chair metaphor in plate 1 reinforces the three dimensions that are required in order for humans to live better. If any of the three legs become weak, society becomes unstable. Willard however questioned the applicability of this metaphor in real life given the fact that the economic, environmental, and social legs in reality do not appear separate and equal. The three-circle model shown as plate 2 seems to suggest that the central area where all the circles overlap is home for sustainability. The tricky issue with this model is that the size of the overlap is always dependent on the user of the model and their intentions, etc. It is therefore not uncommon for a business user of the three-circle model to enlarge the overlapping area for the economic pillar in excess compared to the overlapping areas for the other two pillars (Willard, 2010). The environment protection propagator would increase the environment pillar, with the social enthusiast doing the same for the social pillar. Another limitation of this model, as pointed by Willard, is that the parts of the circles that do not overlap have an existence of their own.

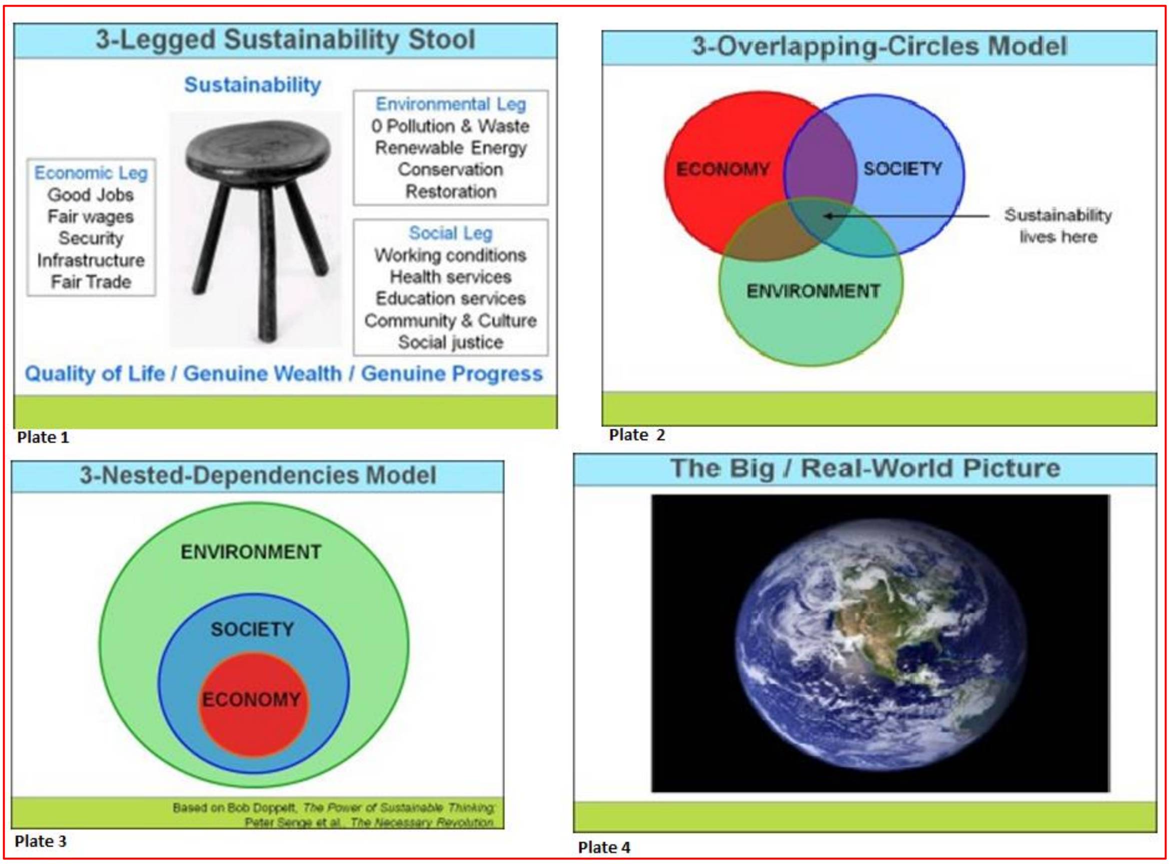

Figure 3.1: Sustainability models (by author from Willard, 2010).

To remind some critics about the real “REAL WORLD”, plate 4 has been added to Figure 3.1. Plate 4 is a satellite image of planet Earth showing water, atmospheric clouds, and land. In plate 4, one can see neither people nor their economies. Clusters of people on land however form societies within that larger environment. Willard’s assessment of this model seems to lean towards the nested model (plate 3), which sees the environment as the dominant pillar of the sustainability models. This therefore emphasises that humans must not extract too many resources from Earth such that Mother Nature will not be able to cope. A pyramid-like model resembling that presented in plate 3 appears in the Environmental

Education work conducted on behalf of the United Nations Environment Programme in response to the AMCEN Arusha Declaration of 2012. This model (shown in Figure 3.2) recognises that while the socio-economic systems are related, they are fully reliant on the biophysical environmental systems (Lotz-Sisitka et al., 2017). The Africa Environmental Education and Action Plan adopts this understanding of the relationship between the three pillars of sustainable development.

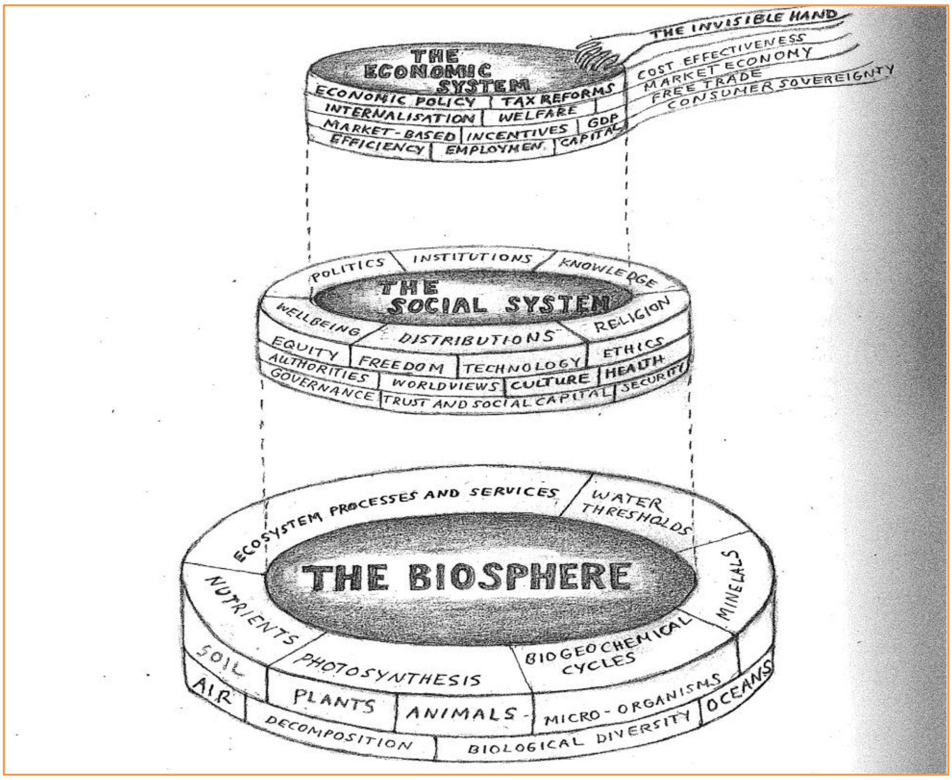

Figure 3.2: The pyramid type sustainability model (Hahn, 2014: 340)

Whether a decision is made to adopt one or all of the four models portrayed in Figures 3.1 and 3.2 above, the phrase "sustainable development" is increasingly accepted as a goal by developed and developing countries. To Kurian and Bartlet (2010), this is a continuous concept marked by several efforts to either improve or destroy it. They view it as a term that lent itself easily to the efforts of global institutions and Government to protect the biophysical environment with the intention to derive wealth from it. It, however, continues to provide hope to those truly concerned with protecting such resources for the present and future generations as per the definition in the 1987 Brundtland Commission report 'Our Common Future' (WCED, 1987).

The socio-economic model includes the neoclassical theory of growth (or development), which, according to Dragulanescu and Dragulanescu (2013), considers enhanced productivity and increased earnings to spend on these products as the best route to poverty alleviation. These authors talked about traditional neoclassical economists who, they argued, consider the economic system as a closed and linear system. They criticised these economists for failing to understand the interrelatedness between the socio-economic and the ecological systems. Economists are further criticised for interpreting the environment as having only an instrumental value. Dragulanescu and Dragulanescu (2013) therefore seem to take the ecocentric environmental world-views discussed in Chapter Two, as they deeply criticise the free-market enterprise (also discussed in this chapter) as a precursor for environmental problems. These writers hence show a close link between sustainable development theories and the green economy quandary introduced in Chapter Two. South Africa holds policy positions, which may fall within the prescripts that favour economic growth models criticised by these authors. These positions, as highlighted in National Treasury (2019), identify manufacturing as a key growth and employment driver capable of enhancing growth in the Gross Domestic Product, the manufacturing of value added products and increased exports. In the process, jobs created are deemed critical to enhance the socio-economic and the environmental protection status of the country's citizens.

The ecological model, on the other hand, considers biological diversity and ecological integrity (Allen and Ervin, 2007), while also emphasising that there are physical limits to ecosystems. It recognises that human systems are dependent on biological systems for the environmental goods and services that support life, social and economic functioning of societies. An important consideration for sustainability-oriented policymaking and management, according to Harrington (2016), is the capacity of a system to remain productive. South Africa has developed a series of legislative frameworks aimed at upholding the rights of citizens as preserved in the country's supreme law. They contain provisions aimed at protecting the environment for the benefit of present and future generations (Government Gazette, 1996: 1251-1252). South Africa is continuously embarking on efforts to green the local industry sector while at the same time supporting efforts to enhance the local manufacturing of green industry components.

For all models of sustainability described in the preceding paragraphs, sustainability concerns promote the indefinite existence of human systems (Changa, Zuob, Zhaoc, Zillantea and Soebartoa, 2017). In order to achieve this, a balance is therefore required between the carrying capacity of bio-physical and socio-economic environmental systems. In this thesis, other theoretical concepts in addition to sustainability theories were considered crucial in supporting the analysis of South Africa's transport greening experiences. These include systems theories, briefly discussed in the following sub-section.

3.4. SYSTEMS THEORY

A systems approach to thinking has very strong conceptual linkages with sustainability concepts discussed in the previous sub-section and relates to critical realism considered by Sayer (2000), Danermark, Ekström, Jakobsen and Karlsson (2002) and Benton and Craib (2001). Introducing critical realism in his book, Sayer (2000: 14) cited Lawson (1997) and claimed that social systems commonly involve 'combinations which causally affect the elements or aspects, and the form and structure of the elements causally influence each other and so also the whole'. This kind of thinking is useful in conceptualising sustainability in that the economic, the social and the environmental pillars all influence one another. Systems theories recognise that organisations are complex social systems, where separation of parts from the whole system, reduces their overall effectiveness. Mele, Pels and Polese (2010) noted that, ever since Aristotle's theory of holism in metaphysics, researchers have battled to understand the composition and function of systems. As a Greek concept referring to 'all, entire or total', holism, according to *Environment and Ecology* (2019) refers to the idea that all properties of a given system – socio-economic or biophysical – are not explainable in isolation. The system as a whole plays a significant role in determining how the parts behave.

An article written by Goodman (1997) provided a perspective that sets a good foundation for people new to the field of systems thinking. The article addresses many questions about systems thinking, ranging from what does this system involve, when should it be used, why and where should it be used and how should it be used. Goodman referred to systems thinking as an approach that requires accepting that there are often multiple ways to resolve problems, including willingness to take unpopular decisions. Unlike the later writers who include the fourth levels as indicated in Figure 3.3 below, Goodman only presented three models (events, patterns and structure). The Northwest Earth Institute (2017) identified and attempted to describe the Iceberg model in Figure 3.3, as one of the key tools for guiding systems thinking.

The Iceberg model differs from the three levels model presented in Goodman's article. It identifies four elements that make up any system: the event, the pattern/ trends, the underlying structures and the mental models. The event level is the level at which we typically perceive the world, and is usually very narrow. As a concluding remark in their book *Explaining Society: Critical Realism in the Social Sciences*, Danermark et al. (2002) noted that "things do not happen by chance or without a reason. Behind events and courses of events there are powers generating them. Taking a closer look below the event level, patterns/trends start to emerge, which is the next level in the Iceberg model. These are similar events, which may have been occurring over time, and observing patterns allows us to forecast the events. Below the pattern level, is the underlying structures, which have an effect on the patterns. Below the structure is the mental model level, which refers to the intangible phenomena probably learned from previous experiences, family and societal upbringing. These are value systems, the worldviews and belief systems, which serve as main drivers to the existing structures. The mental level, according to Huigens (2010), is submerged deep within the iceberg and thus is seldom explored.

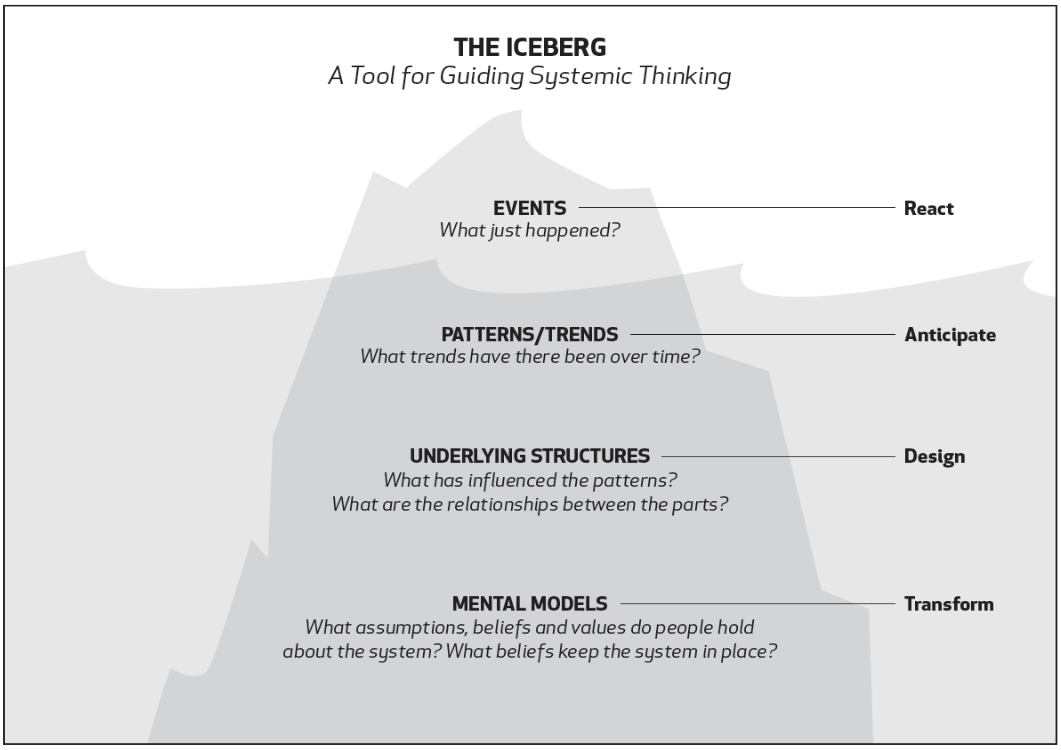

Figure 3.3: The Iceberg model (Northwest Earth Institute, 2017)

Arguments on the application of the systems theories in both the natural and social sciences have been made in *Environment and Ecology* (2019). Here, scientists, anthropologists, ecologists, economists, sociologists, philosophers, medical scientists, psychologists, etc. are said to have engaged in debates and applied this theory in their fields (Mele et al., 2010). Using Rhodes University as a case study, Togo (2009) used the systems approach to investigate the manner South African universities can best adopt and incorporate the concept of sustainability in their duties. Sexton and Stanton (2016) provided examples of other applications with the use of new terms such as Systems Biology, Systems Engineering and Systems Psychology. Systems theory can hence assist in providing a multi-disciplinary study of systems in general.

In the context of this study, the South African Government can be viewed as an organisation with many parts in the form of organs of state organised in terms of the country's supreme law, the Constitution (Act No. 108 of 1996). Chapter Three of this Constitution makes provisions for co-operative governance between the state organs when dealing with issues of national interest. Government is comprised of three spheres, namely the national, provincial and local, which are regarded as distinctive but interdependent and interrelated institutions. The relevance of systems thinking in this research is explained further in sub-section 3.7. The third theoretical framework with concepts deemed relevant to this research is the framework linked to globalisation theories, discussed in the following sub-section.

3.5. GLOBALISATION THEORIES

There is much disagreement among scholars, according to Robinson (2007), on the definitions assigned to the concept of globalisation as well as on the conceptual frameworks to understand it. This writer noticed, however, that globalisation theories are closely related to ideologies such as Marxism, Weberianism, functionalism, postmodernism, critical and feminist theory. Robinson also drew on the work of Robertson in 1992, which he believed provided the most widely accepted definition of globalisation among scholars as follows:

> Globalization as a concept refers both to the compression of the world and the intensification of consciousness of the world as a whole … both concrete global interdependence and consciousness of the global whole in the twentieth century (Robertson 1992: 8, as cited in Robinson, 2007:138).

In 1995, Robertson introduced the concept of 'glocalisation', meaning the global outlook adapted to local conditions (Robertson, 1995). This is very much in line with globalisation *Theories of Space, Place and Globalisation,* one of the seven globalisation theories which Robinson described in his 2007 work. Of the seven theories, the world-system theory and the theories of global capitalism relate to the economic and political spaces, and as such were deemed more relevant to the discussion in this dissertation. They both provide a critique of the capitalist system. Others relate to, among others, immigration, ethnic formations or integrations, labour and gender roles, information technology and networking

3.5.1. The World Systems theories

The World Systems Theories link what happens in the world economy today to the capitalist world-economy that emerged many years ago in West Europe. This is an economy, which Robinson argued:

> …expanded outward over the next several centuries, absorbing in the process all existing mini-systems and world-empires and establishing market and production networks that eventually brought all people around the world into its logic and into a single worldwide structure. Hence, by the late nineteenth century there was one historical system that had come to encompass the entire planet, the capitalist world system – a truly 'global enterprise' (Robinson, 2007: 128-129).

Developed around 1974 by sociologist Emmanuel Wallerstein (Robinson, 2007; Wu, 2016 and Hurst, 2018), the World Systems Theories classify the world into three categories (core, periphery and semi-periphery) as portrayed in Figure 3.4 below. Core countries (developed worlds) exercise control over peripheral countries in many ways including exploitation of labour and raw materials. On the other hand, the latter (semi-periphery/ developing countries and periphery/ underdeveloped) countries are dependent on the former countries on many aspects including prosperity, politics, military power and the economy (LibreTexts, 2020). As such, the developed regions benefit largely from the global system, where they use their power to obtain raw materials and labour at relatively cheaper rates (Hurst, 2018).

Globalisation theories therefore emphasise the social structure of global inequality, with Japan, Australia, North American and European Union member countries, cited as examples of present day core countries with the most power in the world economic system (LibreTexts, 2020). The semi-peripheral countries (which include South Africa and others such as Brazil, India, Mexico and Nigeria), on the other hand, have features of both core and peripheral countries (see Figure 3.10). Most countries in Africa and low income countries in South America are classified as periphery countries in the World Systems Theory. Related to these theories is the coercion model presented by Major (2013) in the article entitled "Transnational State Formation and the Global Politics of Austerity".

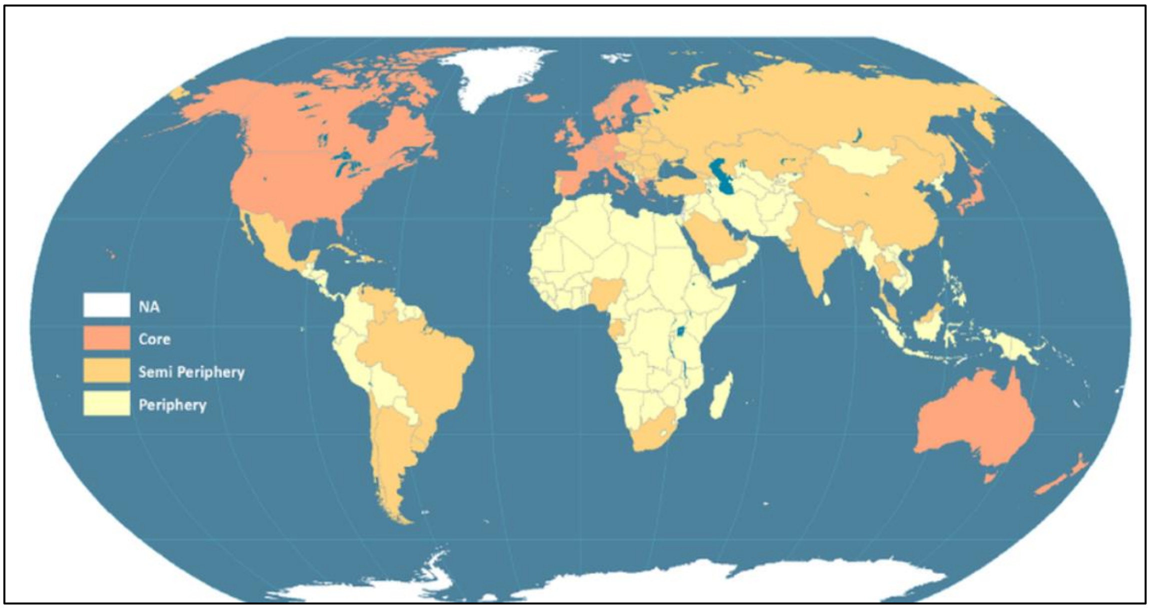

Figure 3.4: World map of core, periphery and semi-periphery countries (Wu, 2016)

Regarding international policy diffusion, the coercion model stresses the role of inequality in power sharing and resource distribution among global participants. As such, the developed regions use existing global economic and political structures to pursue and enforce their goals to other nations in the developing regions (Major, 2013). Based on the work of sociologists like Emmanuel Wallerstein, the literature on the World Systems Theories provide some insights on the world order, giving some understanding on the likely inequalities that characterise such order. It is however important to weigh up the discussion against other globalisation theories, such as the Theory of Global Capitalism discussed in the next sub-section.

3.5.2. Theory of global capitalism

Besides the argument on the core country dominance over what the periphery country can or cannot do as described in the World Systems Theories above, some periphery and semi-periphery countries have committed themselves through a number of international agreements, including those relating to the trading of goods and services (Mlumbi-Peter, 2019), environmental protection (Department of Environmental Affairs, 2019) and international relations, among others. With this in mind, much of what is happening in transport greening in countries like South Africa, seems to be strongly linked to these international forces, especially the desire to curb the emission of greenhouse gases as alluded to in the Green Transport Strategy of the Department of Transport (2018). This then brings in another globalisation theory – the theory of global capitalism, which like the World System theory discussed above, also provides a critique of capitalism.

The Theory of Global Capitalism, however, views the emergence of such institutions as the World Trade Organisation, the World Economic Forum and the Trilateral Commission as clear symbols of emerging structures to rule the world (Robinson, 2007). This decentralised kingdom, according to Robinson, seeks to offer a new world order that penetrates not only into the economic and political systems, but also into the socio-cultural aspects of life, including penetration into the mental and physical aspects of human life. Robinson (2017) makes reference to the automotive value chain, the production process of which is now decentralised and fragmented into many different stages, across many countries. The provision of parts and assembly lines may now be located away from the Original Equipment Manufacturer (OEM) countries. While global capitalists can now freely search for the cheapest labour, lowest taxes and latest regulatory environments, Robinson (2017) noted that this capitalism now faces unprecedented ecological, social, economic and political crises. Capitalism's expansive and destructive logic, according to this writer, has failed to achieve ecological equilibrium and an environment favourable to life, and as such the system needs to be transformed. As opposed to trying to restructure this system, as has been done before, the best option could be to transcend it. Any major transition according to this writer, should however be underpinned by a shift to the so-called "ecosocialism", defined in Löwy (2018) as a system that 'offers a radical alternative that puts social and ecological well-being first'.

Related to Robinson's description of global capitalism, is an article by Major (2013), which identified three mechanisms (termed *competition, emulation, and coercion*) on how this world order operates. The coercion model already introduced in the preceding sub-section relates to the Worlds Systems Theories. As opposed to 'force' by core countries, Major (2013) believed that, economic competition is the main driver behind the types of policy tools that developing world governments adopt. It exerts pressures, which leaves the developing world territories with less choice but to pursue corporate-friendly policy adjustments in an effort to remain competitive at an international level (Major, 2013). This writer hence alluded to many cases of competition theory's real life experiences where external investors from core countries gained access, owned and controlled most resources critical for economic growth in the periphery regions. These cases are therefore explainable by means of this competition thesis. The model is however criticised for having failed to provide generalisable explanations of international policy diffusion. Instead, global economic forces are argued to have led to varying effects (Major, 2013). While this model views governments as institutions that are submerged into the world systems, the emulation model discussed in the following paragraphs, according to Major, has proved to be more generalisable to most international cases. Of relevance to the Theory of Global Capitalism is the *emulation model*. This is a system of global institutions including governmental and non-profit making organisations, which according to Major; develop formalised procedures and directives on how humans should behave. With respect to global policy diffusion, the emulation model hence suggest that if specific policies and practices diffuse across the globe, it is not because of economic pressures but rather because national-level policymakers emulate world cultural norms of bureaucratic rationality, national citizenship, rational justice, and managed economic growth (Major, 2013).

Based on the discussion of various globalisation theories, including examples of international agreements signed or ratified by South Africa, as alluded to in the preceding paragraphs, there is no doubt that South Africa (a semi-periphery country as depicted in Figure 3.4) is indeed a global player. It has made numerous commitments on matters of global concerns, including signing and ratifying various agreements relating to environmental protection, international relations and trading of goods and services among others. South Africa is also a former colony of Western European countries including Britain. It imports and exports many products to various parts of the world including finished automobiles and related components from the core countries and other semi-periphery countries. While it plays a visible role in the export of key automotive greening components, notably catalytic converters, to core countries such as the European Union, the sustainability of such markets is solely a function of developments and decisions in these core countries. The market for catalytic converters arose as a result of EU Emission Standards introduced in Chapter Two. With further developments in the electric vehicle industry as a response to EV roll-out and ICE ban targets in these countries, catalytic converters may no longer be in such demand from 2030 onwards. The importance of global value chains and globalisation theories in this context therefore cannot be ignored.

While the Republic of South Africa is classified into three levels of governance (Government Gazette, 1996), based on its global ties, a fourth sphere – international governance – is also important. What happens in South Africa is undoubtedly influenced by international forces. A number of automotive Original Equipment Manufacturers (OEMs), with a presence in South Africa, originate from core regions. These simultaneously have an upper hand on which automotive technologies to bring to South Africa. They control what can be manufactured locally and what cannot through their decisions on whether to pursue vertical or horizontal integration processes (OECD, 2016). In November 2016, following the OECD Round Table on the Future of the Automotive Industry, a background document revealed the following with respect to the automotive value chains in South Africa:

> In smaller production locations like South Africa, only less complex components or no components at all are produced locally: Company 1 is not producing any components in South Africa and applies the so-called 'complete-knocked-down' (CKD) model of assembly. CKD assembly means that all or almost all components are imported from the Company's production plants in other countries. This model is often applied in countries trying to develop an automobile industry and applying higher import tariffs for already assembled vehicles as compared to tariffs for automobile components (OECD, 2016: 26).

Hurst (2018) places globalisation theories very much closer to the systems theories already discussed in the preceding sub-section, when arguing that a nation's economic system cannot be understood without reference to the world system of which it is a part of. This is similar to the argument that, an individual person's behaviour cannot be understood without reference to their surroundings, experiences, and culture. Major (2013) description of how international policy diffusion affects receiving country's policy decisions can be concluded by claiming that the behaviour of government in the periphery and semi-periphery regions of the world are influenced by what is happening at global levels, specifically the actions of the core countries.

3.6. Relationship between theoretical frameworks

The four theoretical frameworks discussed (sustainability, systems theories, interventionist theories and the globalisation theories) have many linkages as depicted in Figure 3.5, which provided a strong case for their use in this research. In the context of South Africa, all these concepts originate from abroad, hence demonstrating the role globalisation has had on the lives of South African decision makers. On applying concepts within the systems theories, it is important to note that South Africa is just a player (and a small player) in a bigger global system. As a result, the politics, the economy as well as the culture of South Africans are very much influenced by what is happening at global levels. This then brings in another dimension that can be explained using the globalisation theories discussed in the preceding sub-sections, hence introducing the relationship between systems and globalisation theories depicted in Figure 3.5. South Africa's participation, ratification of and acceding to world-driven climate change related conventions, attests to the global influence on the affairs of this country. This introduces another element – intervention – again influenced at global levels. Also, the same free market enterprise, the Keynesianism and the neoclassical economic systems discussed in Chapter Two, feature standpoints originating from abroad. 'Borrowing' in socio-economic systems in this way is evident in the promoting of greening of the transport sector.

These are interventionist elements, again influenced not only at national levels, but also at global levels. South Africa is likely to have done this as a result of either the emulation, competition or coercion modes of information diffusion described in the Global Capitalism Theories. The interventionist strategies to the transport affairs of this country have an international origin, as the international community has identified this sector as one of the major global contributors to the air pollution and global warming problems. South Africa, being a global player and one of the identified major contributors to the problem, intervened by adopting international emission and fuel economy standards to correct the externalities from failed free-enterprise systems.

So, what happens in South Africa in terms of efforts to green the transport sector is a reflection of what happens in the global whole. The system, according to Environment and Ecology (2019), therefore plays a significant role in determining how the parts behave, in this case, a part being South Africa.

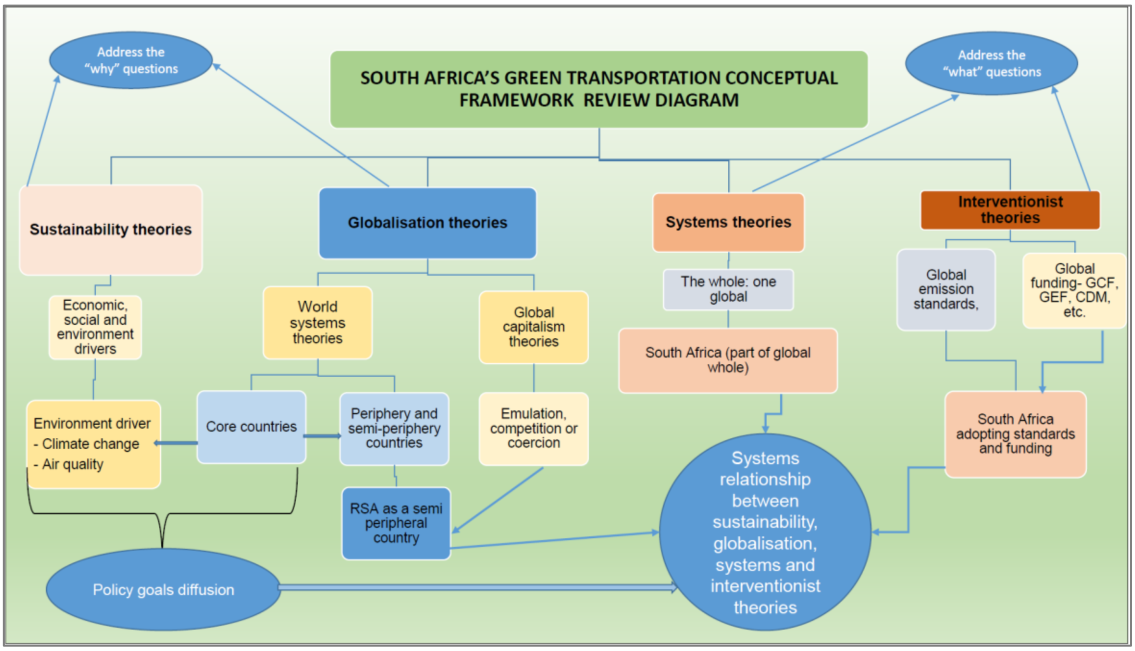

Figure 3.5: Relationship between theoretical frameworks (by author)

The third theoretical framework, sustainable development, is at the heart of debates around transport greening. Any talks about climate change, air pollution and the socio-economic aspects of the transport sector, have close links with concerns raised at global levels. The relationship between the socio-economic and the ecological systems, made sustainability theories one of the key tools to provide interpretation of certain government response measures to transport sector greening. This thus links well with the globalisation, systems as well as interventionist theories. Since human action contributes tremendously in altering planetary systems, a certain level of intervention is therefore required to correct the very same actions that have led to the detrimental impacts, hence the discussion around the role of intervention theories. The urgency for South African policy making institutions to work together, collaborating with the world towards ensuring sustainable transportation, contribute to a strong relationship between the four theoretical frameworks portrayed in the figure above.

3.7. How these theoretical frameworks were used in this research?

Many conceptual frameworks exist that can be used to guide an enquiry into the South African situation with respect to Government's approach to green transportation. Embedded in Figure 3.5 above is an indicative summary of how the four theoretical frameworks relate in this research, with systems and interventionist theories used mainly to answer the "what" questions as discussed in the subsequent subsections. The sustainable development and globalisation theories were used to answer the "why" questions. This is discussed further in the following sub-sections. This research involved interaction with individuals, private sector organisations as well as government institutions at local, provincial and national levels. But it also involved interaction with institutions at global level. Hence, the scale seems to be from micro, meso to macro levels as defined in Perrin (2014). The decision to use all four theoretical frameworks can be explained better through the examination of the relationship portrayed in Figure 3.5. Regarding the question of how these theories were used in this research, a response is provided below and this should be read together with Chapter Four. In these sections, it is explained that theories can be tested, falsified, motivated, generated, illustrated, explained or refined. Theories can be used to either describe, explain or explore the phenomenon being studied. In the case of this research and commencing with the interventionist theories, this is how the theories were used.

3.7.1. Interventionist theories

For issues related to government response mechanisms, the strong provisions of the interventionist theories enabled the author to describe how Government has responded to the transport greening agenda. The examination of policy and legislative provisions highlighted the Government's position in this agenda. In this case, these theories were used mainly to describe the status quo, for example, what Government has done as opposed to what the Government has not done. The description of the status quo in Chapter Five attests to this, where policy and legislative frameworks related to fuel quality, fuel economy, alternative fuels and vehicles, modal shift to non-motorised transport, are described in detail. Attempts were also made to provide an explanation of these provisions. It is not only what the legislation says that is important but the reasons behind Government's adoption of certain policy strategies as well as silences on others. To answer the 'why' questions, sustainable development theories were useful as discussed below.

3.7.2. Sustainable development theories

These theories helped to address the 'why' questions. It was noted in the preceding section relating to these theories, as well as in Chapter Two, that many drivers exist. These could be economic, social or environmental. Many issues that emerged in this research could be explored and explained using sustainability theories. By ratifying and acceding to international conventions to reduce GHG emissions, South Africa's stated intentions could clash with the real issues, where this country's need to address pressing socio-economic needs could have pushed it to ‘go with the flow’ so as to access the financial resources of the world’s biggest polluters. In this case, sustainable development theories were used to develop new concepts/ theoretical frameworks. Another example relates to Government levied import duties on green vehicles, fuel inefficient vehicles, etc. Using these theories, it should be noted that the publicised rationale (i.e. changing of human behaviour) may not necessarily be the ultimate goal. The collection of revenue to fund the national budget, could be the ultimate goal. These are only a few examples on how sustainable development theories were used in this research.

Others relate to levies on certain green fuels while silence is maintained on others. The theories were used in this study to evaluate and explain the status quo in terms of sustainability thinking amongst South African policy makers. The concepts borrowed from the three sustainable development models presented above helped explore decision makers’ world views and perceptions on transport greening. They helped to answer the question of priorities as South Africa attempts to balance its green transportation ambitions with all its other national imperatives of socio-economic development and environmental protection.

3.7.3. Systems theories

The applicability of systems theory in this study was based on the understanding of transport greening as a multidisciplinary subject. It is a subject that cuts across finance, economics, engineering, planning, environmental science, transport, energy and many other areas of public policy. These are policy spaces which, it is argued in this research, are fused together by South Africa’s Constitutional call for unity and integration. Linking this to the systems theories assisted to build a systems view of the country’s various policy components which could not be studied in isolation. Attention was therefore placed on the policy space across government departments, considering that the Government’s overall national imperatives are integrated and interlinked. The individual properties of such a phenomenon, as Mele et al. (2010) argued, become indistinct.

To understand Government’s responses to transport greening and the effects of such responses, the basic approach would be to examine the work of all organs of state that are considered key and relevant. It would therefore not make any sense to limit the assessment to a single organ of state, e.g. the Department of Transport only. Such a department does not regulate the budget and all finances linked to transport sector greening on its own; another national department, National Treasury, does this. The same applies with other mandates, e.g. environment protection, research and development, energy supply, mining, mineral beneficiation, trade and industry. By virtue of these departments being responsible for mandates that impact on transport sector greening, they are equally important in transport greening decision making. If the Government of South Africa is to succeed in taking this country to sustainable green transportation, a certain level of harmony in policy direction is required between all relevant and implicated organs of state. They should not perform as individual structures independent of one another.

A report on the Second Biogas Conference held in 2015 noted the debates on whether the various government departments involved in biogas for mobility are working together or in silos. Panellists according to this report refuted the notion that government departments operate in silos; they argued that structures have been put in place and that the departments frequently meet and engage with each other (Department of Energy and SABIA, 2015). The question to be answered was then, to what extent are these engagements effective? Why are concerns about a lack of coordinated efforts evident? Are these concerns created, or are they indeed valid? It is these kinds of questions that this study attempted to address borrowing ideas from the systems theories. The research used Systems Theory as an interdisciplinary framework to investigate and provide answers on the country's green transport policy environment from a holistic perspective. Similar to the interventionist theories discussed above, the research further used systems theories to address the "what" aspects of the Government's response mechanisms. As explained in the Iceberg model (Figure 3.3 above), moving from the events deep below the surface of the iceberg allowed the author to see the patterns, underlying structures and mental models associated with various Government responses to transport sector greening.

3.7.4. Globalisation theories

Unlike the interventionist and systems theories, the thesis used globalisation theories to respond to the "why" issues of this country's transport greening regime. Globalisation theories are similar to sustainability theories and answer many questions relating to South Africa's adoption of global strategy frameworks such as the UNFCCC, emission and fuel efficiency standards. This country ratified and acceded to these international conventions. Reasons for this could be related to global socio-economic and environmental policy imperatives, hence allowing these theoretical frameworks to contribute to exploring these often hidden agendas. The theories were hence used to explain reasons behind certain decisions taken at national, local and provincial levels, and to link these reasons to the global diffusion of transport greening culture, attitudes, economics, technology, politics and others.

3.8. CONCLUSION

This chapter has provided a review of conceptual frameworks which were deemed crucial in the context of this research. Green transportation has its roots in the global debates around the concepts of sustainable development and green economy of which green transportation, sustainable transportation/ eco-mobility form part. Four major theoretical frameworks were reviewed including interventionist, sustainable development, systems as well as globalisation theories. The chapter described the relationship between the theoretical frameworks used, which showed strong interlinkages, mainly due to the global origin of these frameworks. Due to these interlinkages, this research did not single out one of these theoretical frameworks, but rather used them all. It used them to provide a description of how the Government of South Africa has responded to global calls for a transition to a greener transportation regime. It also used the theories to explain why Government chose specific routes as presented in Chapter Five.

CHAPTER FOUR

RESEARCH METHODOLOGY AND DESIGN

4.1. INTRODUCTION

Various definitions of the term ‘research’ exist depending on the purpose of the research. As defined in Harmon, George, Morganph, Jeffrey and Glinerph (1999), Hopkins (2002) and Naidoo (2011), however, this usually refers to an impartial and well organised process of data collection and analysis, in a manner that validates and refines existing knowledge and generates new knowledge. The objective could be to generate methods aimed at assessing critical concepts. It could also be to define applicable phenomena and relationships between these phenomena. The objective could be to offer evidence for the effectiveness of a particular technique or to support the theoretical base of a particular discipline (Harmon et al., 1999). In this chapter, the concept of ‘research’ is based on the understanding provided by these authors. The definitions assigned to the terms ‘methodology’ and ‘design’ have also been borrowed from various authors. The ‘onion model’ appearing in the fifth edition of the book by Saunders et al. (2009) is also used throughout this chapter. This book uses similar definitions for research as the writers above.

The intention of this chapter is to explain and describe to the reader the approach followed in conducting this research. While it provides an account of the theoretical/philosophical underpinnings adopted to inform the early stages of setting the research aim, objectives and problem statement, the practical methods used in data collection, analysis and presentation of findings, are also presented here. The overall approach is hence presented in six sections, which include the current section (introduction). Section 4.2, the research methodology, which presents the conceptual framework most relevant and hence adopted in this research, follows this. Third, the research design including the methods used to collect and analyse the data, is presented in Section 4.3. The fourth section (4.4), discusses the challenges encountered as well as an overview of how they were addressed. Section 4.5 addresses issues relating to ethical considerations. Finally, the chapter is concluded by providing a brief summary of the key issues covered.

4.2. RESEARCH METHODOLOGY

To describe the research process, Saunders et al. (2009) developed an onion-like model similar to the one in Figure 4.1. This model contains several layers, which ought to be employed consistently when conducting research. The author has noted various versions of this model, which include the 2003 model cited in Mafuwane (2011: 69), the 2009 model cited by Mayer (2015) and the 2012 model cited in Omotayo and Kulatunga (2015) and shown in Figure 4.1. While these versions differ slightly especially in terms of the layer contents, in general, they are built along the same principles, with an inner core and four to five outer layers. The model requires that the outer layers are addressed first before the researcher addresses the data collection and analysis making up the inner core. These issues include a need to clarify philosophies underpinning the research, decisions on research approaches and strategies as well as time horizons. These layers appear in the outer layers of the onion.

While Gog (2015) acknowledged that the onion model is widely used, he proposed a different approach suggested by Jonker and Pennink in 2010. This alternative approach presents a more hierarchical process to conducting research, with the steps in chronological order depicted as research paradigm at the top of the pyramid, research methodology in the middle top, research methods in the middle bottom and research techniques at the bottom of the pyramid. These principles look similar to the onion model. This, coupled with the fact that several authors have used the onion model, led to this thesis also using the research methodology and design of the pyramid, adopting the principles embedded in the onion model by Saunders et al. (2009).

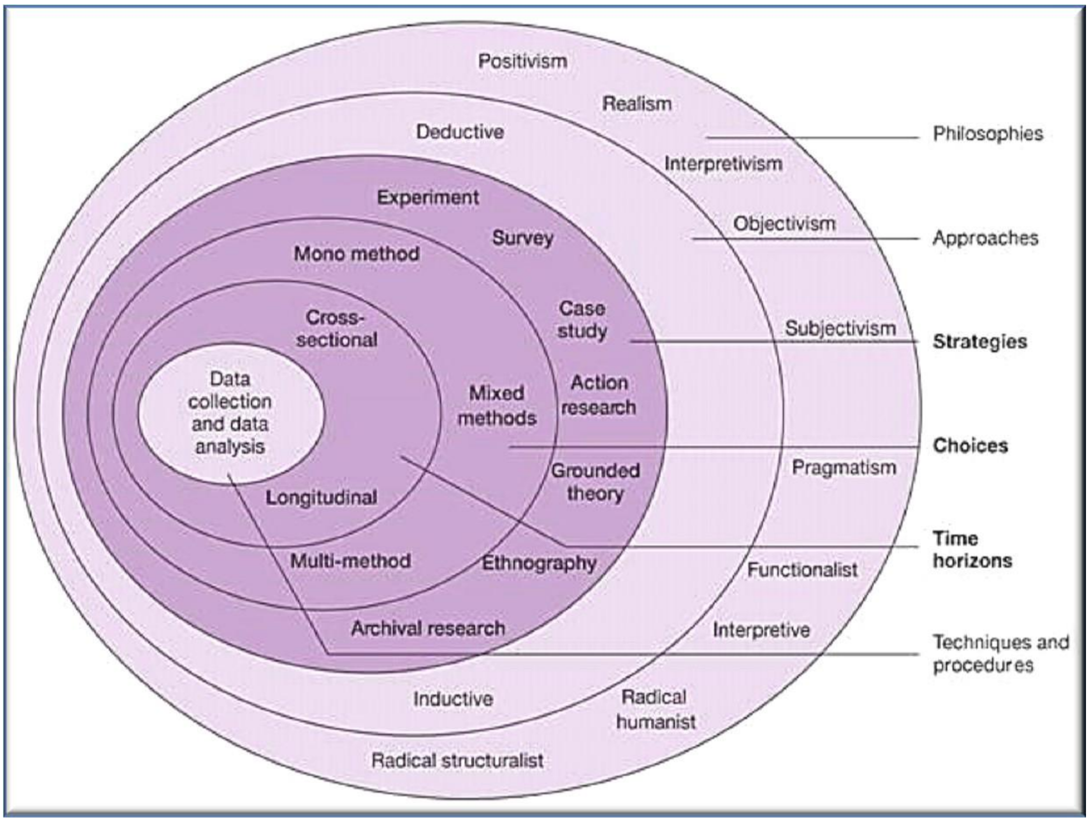

Figure 4.1: The research onion (Source: Omotayo and Kulatunga, 2015)

4.2.1. Research philosophy

Research philosophy according to Saunders et al. (2009) refers to the ideologies about how the data is collected, analysed and interpreted and how knowledge is developed. It therefore builds the basis for the research process and allows researchers to make known, key assumptions about worldviews. Numerous philosophies exist, with the major ones relating to epistemology, ontology and axiology. While epistemology concerns what constitutes legitimate information in any given field of study, ontology refers to the nature of the truth under scrutiny. Both are philosophical foundations, which have a big impact on all aspects of a study (Graue, 2015). Axiology, on the other hand, relates to the researchers' own value systems and the way in which the researcher manages them during the process. Philosophical sister positions attached to these three worldviews include, among others, positivism, interpretivism, pragmatism and realism. These feature prominently in various versions of the onion model. Other positions include constructivism, objectivism, subjectism, functionalist, radical humanist and radical structuralist. Based on the 2012 version of Saunders et al.'s onion model, Omotayo and Kulatunga (2015) have discussed these philosophical positions. The epistemological worldview of interpretivism has more applications in a qualitative research environment, and was thus used as the dominant approach for the current research and is discussed in the next section. As opposed to positivism, which normally adopts quantitative methods (which tend to view the world through observable and measurable facts), interpretivism adopts humanistic qualitative methods. The latter views the world through the perceptions and experiences of the participants (Thanh and Thanh, 2015). Thus this philosophy has been described as an epistemology that requires researchers to understand differences between humans as social actors. It assumes the following:

> … that, as humans, we play a part in the stage of human life. This emphasises the difference between conducting research among people rather than objects. The researchers hence have to adopt an empathetic stance, entering the social world of their research subjects in order to understand the world from their point of view (Saunders et al., 2009:116).

By virtue of this research having an interest in Government responses to green transportation, interpretivism, as described in Saunders's quote, was deemed to be of most relevance. This philosophy was adopted as one of the epistemological worldviews capable of embracing the meanings inherent in people's attitudes, beliefs and opinions. The research was conducted in natural settings, which according to Pham (2018) allows research to gain a deeper understanding of the phenomenon being studied. The research objectives sought to evaluate policy/ legislative provisions and to solicit people's views on Government response measures to transport greening. It should be noted that the author was a full-time employee in Government, serving in a work area that promoted a transiton to a greener economy. The author met with the research participants as part of his Government official duties in various events deliberating on transport greening issues. Official work activities comprised several assignments in the energy and transport sector greening areas, and as such the author was immersed in the culture of the phenomenon being studied. This describes a situation which Atieno (2009) considered a form of qualitative research and the best way to understand what is going on – moving into the culture or organisation being studied and experiencing what it is like to be a part of it.

Although interpretivism was the main philosophy adopted in this research, the author was mindful of its limitations as noted in Pham (2018). The philosophy has been criticised for its tendency to leave a gap in verifying (using scientific procedures) the validity and usefulness of research outcomes. It has also been criticised for an ontological tendency to be subjective rather than objective. Often refered to as 'anti positivist' paradigm due to its origin as a reaction to positivism, Mack (2010) also noted that this philosophy may allow the research outcomes to be overly affected by the researcher's own interpretation, belief system, ways of thinking or cultural preferences.

Interpretivism is, however, praised on grounds that the primary data generated via studies using this philosophy, are often associated with a high level of validity (Research-methodology.net, 2019). This is due to the data's tendency to be trustworthy and honest. Kabir (2016) also praised the semi-structured interview technique for its ability to provide reliable and comparable qualitative data. While the author was part of the government system during the research period, not all policy and legislative documents reviewed had been developed during the author's time. To a certain extent, the policy provisions in these documents existed outside the 'author's world', as detached objects from which the author had to derive knowledge. Thus positivism could play a minor role in this research too. In other words, qualitative research was complemented with a few quantitative methods, especially during the analysis of document and interview data collected, as discussed in the subsequent sections of this chapter. Interpretivism remained the dominant philosophy that guided the research process. This was due to the belief that, whether embedded in reports, policy/legislative documents or expressed in verbal form, the worldviews in various data sources used, reflected attitudes, feelings, emotions, concerns, wishes and motives of the people who developed them. As such, data sources carried meanings which were deemed crucial in generating knowledge about South African Government responses to transport industry greening.

4.2.2. Research approach

The literature identifies two distinctive approaches to research – quantitative and qualitative techniques, which, as argued in the preceding sub-section fall within positivist and interpretivist philosophies, respectively. While these methods, according to Shaw and Wheeler (1994), differ, they both entail problem identification, development of an aim and objectives/ research questions, identification of a conceptual/philosophical framework and the selection of methods to collect and analyse the data. Quantitative studies test hypotheses by using objective, measurable processes hence using deductive logic which Meurer (2007) believed involves anorganised examination of real-world and tangible phenomena using numerical technics. The approach hence concentrates on using literature to identify theories and concepts for testing the data collected. The difference between the two approaches is depicted in Figure 4.2, where qualitative approaches, according to Robinson (1998), recognise the value of phenomena that cannot be seen.

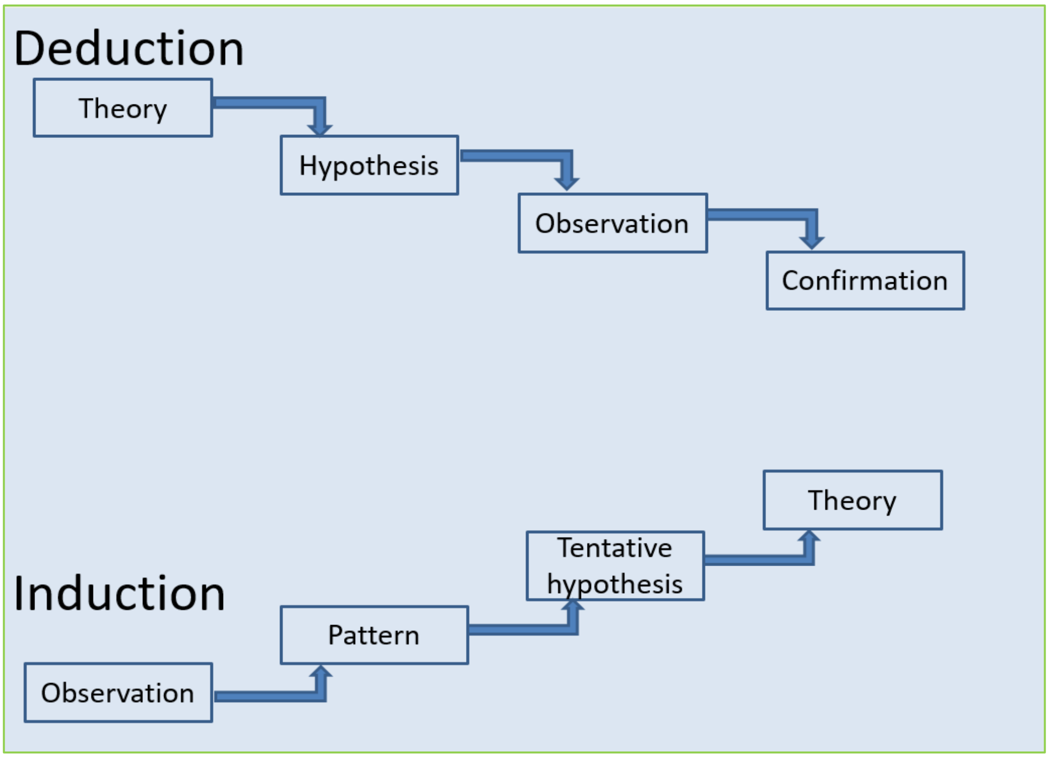

Figure 4.2. Inductive vs. deductive research methodology (Adapted from Farquhar, 2012:24)

Qualitative approaches hence adopt an inductive approach, which involves collection of data, observation right through to the development of a theory based on the results of data analysis. These approaches, according to Mehdi and Mansor (2010), locate the observer in the world, hence allowing the researcher to study things in their regular format with little to no interruption. An inductive approach is therefore used to understand the core reasons for certain behaviours. It can also be used to gain further insight into phenomena and to develop ideas for later quantitative research. It can further reveal trends in opinions and thoughts. The researcher describes and interprets human behaviour based primarily on the words of selected individuals and/or through the interpretation of their material culture or occupied space (University of Southern California, 2016). It is flexible and a useful approach in investigating information about the “human” side of an issue – that is, the often contradictory behaviours, beliefs, opinions, emotions, and relationships of individuals (Family Health International, not dated). This approach, according to Meurer (2007), exists on a spectrum of scientific investigations and it seeks to explore meanings and opinions and to generate hypotheses regarding decision-making and behaviour by using inductive reasoning. The final product here could be any kind of general explanation or some form of theoretical constructs. It is a process which Creswell (2009) outlined as follows:

- Researcher poses generalisations or theories from past experiences and literature;
- Researcher looks for broad patterns, generalisations, or theories from themes or categories;
- Researcher analyses data to form themes or categories;

- ❒ Researcher asks open-ended questions of participants or records field notes; and
- ❒ Researcher gathers information (e.g. interviews, observations).

In this study, qualitative approaches dominated the enquiry. They were used to inform the methods of enquiry including data collection, analysis and presentation, as discussed in the following section. Whether conveyed in the form of policy documents or interview responses, the phenomena investigated involved beliefs, attitudes, opinions, concerns and as such were relatively intangible. They included the world views of decision making institutions, as well as individuals who were approached as discussed in the research design section further below. Nonetheless, quantitative tools were also relevant in some instances. Notable examples in this research can be found in Chapter Six, where qualitative data codes and categories are presented in numeric, tabular and graphic formats. Van Wyk (not dated) also noted that, at times, it is difficult to draw a line between inductive and deductive research processes.

4.2.3. Research strategies and time horizon

The literature often cites three types of research strategies: exploratory, descriptive and the explanatory strategies. The exploratory strategy was not relevant to this research, thus the focus is on the other two strategies. Descriptive research, according to the New York University (not dated), frequently aims to describe the nature or characteristics of the phenomena being studied based on data collected from a sample. As such, it asks 'what' questions as opposed to 'why' types of questions. Although some people dismiss this strategy as 'mere description', the New York University deems it fundamental as it adds immeasurably to our knowledge of the shape and nature of societies. Explanatory research, on the other hand, seeks to explain the 'why' questions, while also trying to predict future occurrences. As such, this is where theory proving/ disproving/ explaining comes in. This involves developing causal explanations, which normally argue that phenomenon Y is affected by factor X. The choice of a specific strategy thus seems dependent on various factors including the intended ultimate goal and output of the research. These could include testing, falsifying, generating, illustrating, explaining or refining of a theory.

In this research, while the descriptive strategy was used as a dominant form, the applicability of the explanatory strategy cannot be ignored given that the research developed a number of new concepts as discussed in Chapter Eight. In other words, a hybrid route was followed as is further discussed in sub-section 4.3.2 of this chapter.

4.2.3.1. Research strategies

Literature refers to various types of strategies often linked to each of the two major research approach domains (quantitative and qualitative) introduced in the preceding section. They include grounded theory, *case studies*, action research, surveys, field experiments, *ethnography*, simulations, laboratory experiments, *archival analysis,* role-playing, *content analysis*, and so on. In this study a combination of strategies was deemed relevant: case studies, content analysis, ethnography and archival analysis. While not adopted as a major strategy, the applicability of grounded theory, especially its emphasis on new theory generation, was also given some attention. The following sub-sections discuss these strategies, in line with their relevance to this research.

4.2.3.1.1. Case studies

Robert Yin, described by Karlsson (2016), as a propagator of the case study approach since 1984, has written much about the case study strategy in the research process. In the introduction chapter of his 1994 version of a series of *Case Study Research Design and Methods* books, Yin (1994) regarded case studies in general as a preferred strategy when answers on the 'how' or 'why' questions are required. Twenty years later in the 2014 version of Yin's book, Hollweck (2015) described case studies as providing a "linear but iterative process". Other authors, notable Gog (2015), argued that these studies may be quantitative or qualitative hence seeking to generate answers to questions such as 'what', 'why' and 'how'. It must be noted that Gog and several other authors on case studies (including Karlsson mentioned above) have written much about Yin's work. This includes noting how opinions regarding the definition of a case study are becoming increasingly divided, with most writers acknowledging in-depth investigation of a phenomenon in a real-life context as a common feature of case studies. It is a study which, according to Gog, is usually classified as qualitative by highlighting the in-depth understanding acquired predominantly by qualitative methods. Karlsson's studying of previous literature on case studies revealed various and often conflicting definitions, resulting in concerns over the fame this approach had gained over the years.

Nonetheless, in the case of research presented in this chapter, the phenomenon studied was transport sector greening, which happens to be one case among many economy greening cases in South Africa. It was hence being researched within the broader green economy concept currently being promoted in the country. As such, it was deemed to fit the definitions and descriptions of case studies. As such, the strategy was chosen for use in this research to answer the "what" questions pertaining to the country's responses to transport sector greening. It provided a description of the status quo in terms of how the policy and legislative framework addresses (or does not address) transport greening.

4.2.3.1.2. Content analysis

Another research strategy deemed relevant in this research was content analysis. Content analysis, according to the Colorado State University (2004), involves the search in text, of specific ideas or words that relate to the phenomenon under investigation. Researchers, according to this institution, then analyse the relationship between these words and provide interpretation of messages they are conveying. The initial step involves reading and re-reading the data to get a general understanding of what the participants are talking about. According to Erlingsson and Brysiewicz (2017), this is followed by transcription of texts into smaller and succinct format and coding into various levels, such as sentences, paragraphs. The data is then analysed to form categories or themes thus translating it from literal content to latent meaning. Content analysis hence allows the researcher to determine how many times words appear, whereas relational analysis, often termed 'semantics analysis' by these authors, goes a step further to examine relationships among concepts in a text.

As discussed further in section 4.3 (data analysis) of this chapter, this strategy was used in this research, not only in analysing secondary data, but also in analysing primary data from in-depth interviews.

4.2.3.1.3. Ethnography

Originating mainly from anthropology, ethnographic research involves observation of groups or individuals being studied, in their everyday life setting for an extended period of time. Researchers using this strategy, according to Sangasubana (2011), also participate in activities of the research subjects, hence becoming immersed in their daily activities and ways of doing things. By virtue of the author being a full-time serving official in Government during the time of writing this thesis, involved in green economy-related work as alluded to above, ethnography was deemed appropriate in this research. Among many advantages cited of this strategy, the most relevant one in this research, is related to ethnography's ability to give "an insider's view of reality" given the researcher's insider status as a servant in a government system that was being researched.

4.2.3.1.4. Grounded theory

Another strategy necessary to discuss in this research, though its relevance was negligible compared to other strategies, is Grounded Theory. There seems to be a thin line between this strategy and content analysis discussed above. The difference seems to be around the code and category identification/ generation. While content analysis makes use of categories that are defined before data analysis commences, this later theory requires that themes or categories should be derived from the text analysed (McGraw-Hill Education, not dated). This is based (according to Calman, not dated) on realist ontology, with the epistemology being generation of objective truths, generalisable, testable and verifiable theory. The epistemological roots were therefore one of the main reasons why this approach has been criticised in social science research, as noted in McGraw-Hill Education. Content analysis has epistemological roots in interpretivism, hence making it more relevant in this research compared to grounded theory-based strategies.

4.2.3.1.5. Archival research

This type of strategy, as the name suggests, involves conducting research using information from archived documents. This enables the researcher to examine and provide reasons for developments that have occurred over a long period. One should, however, bear in mind that information obtained this way may contain errors or data that is irrelevant to the current research. Thus other complementary research strategies are required.

This strategy seemed particularly applicable to this research, especially to address the main objective that sought to evaluate Government policies. These documents were located in various areas in Government including electronic records.

4.2.3.2. Time horizon

In an article by Saunders and Tosey, the Rapport (2012/2013) reported that where research is carried out to resolve a problem at a particular point in time, this *'snapshot'* is *'cross-sectional'*, with possible strategies being surveys or case studies. Research that is conducted over a longer time is referred to as *'longitudinal research'*. This entails the use of such strategies as experiment, action research, grounded theory and archival research. Saunders and Tosey did not specify the long versus the short period, thus making it difficult to classify this research either as cross-sectional or longitudinal.

The data collection and analysis through to the final write-up and professional proofreading of this thesis was carried out over a period of about three years commencing from late 2016 to the third quarter of 2019 (excluding the proposal year). These processes (as detailed in section 4.3) proceeded from the proposal approval by the University's Ethics Committee through to the date of submission of the final version of the thesis for examination. The research project had a time frame of about two years. With the time horizon for cross-sectional studies limited to specific time frames according to the Rapport (2012/2013), this research falls under this classification.

4.3. RESEARCH DESIGN

The function of a research design, according to the New York University (not dated), is to provide clear guidelines for collecting and analysing evidence-based data to answer the research question unambiguously. It is not a mode of data collection, but rather a logical structure of the inquiry. In the preceding section, the strategy adopted in this research was described, with the time horizon being cross-sectional due to the dates of the research from 2016 to 2018/2019. To be convincing, the researcher, according to New York University (not dated), needs to be specific about the type of evidence needed/ obtained towards answering a research question, testing a theory or describing a particular phenomenon. As such, issues of sampling, tools to gather the data, analysis and presentation according to this institution, form a subsidiary of what evidence is needed. Starting with data collection measures adopted, this section addresses these aspects.

4.3.1. Data collection

The literature distinguishes between primary and secondary types of data. Hox and Boeige (2005) defined primary data as the original data collected to address a specific objective. Secondary data includes data which was originally collected for a different purpose. Marshall (2006) noted these types of tools that qualitative researchers often use when collecting data: participant observation, in-depth interviewing and document review. While it may be time consuming and costly, the collection of one's own data through primary data methods, such as in-depth interviews, according to Hox and Boeije (2005), allows for the operationalisation of the theoretical constructs, the research design and data collection strategy. In addressing the three objectives introduced in Chapter One and again illustrated in Table 4.1, and with this research having adopted interpretivist epistemological philosophy and qualitative research strategies, these data collection tools became relevant as discussed in subsequent sub-sections.

Table 4.1: Summary of research methods adopted

Objective	Description of data needs	Method of data collection	Method of data analysis
1. To evaluate policy, legislative and incentive regime governing transport greening in South Africa, highlighting the drivers, synergies and gaps	Green economy/ green transportation literature covering local and international technical and policy/legislative approaches	Document review, websites of relevant organs of states, university and work library systems, meetings/interviews with government officials and industry experts	Document/ content analysis techniques
2. To explore views on the current regime and explain the desired policy direction	World views – attitudes, beliefs, opinions, concerns, feelings and other information not readily available in public domain	In-depth open-ended interview guide, participant observations and review of official reports	Content analysis – data coding and categorisation
3. Discussion, comparing South Africa with the top early moving countries and development of a model to inform future policy direction	Literature documents on local and international green transport policy, regulatory and legislative frameworks	Document review, web sites of relevant organs of states, university and work library systems, meetings/ interviews with officials/ experts from organs of states	Document review and content analysis techniques

4.3.1.1. Primary data using interview techniques

Saunders et al. (2009) discussed the importance of interviews as one of the vital tools used regularly in research data collection. Two categories of interviews discussed in Beatty (1995) and McLeod (2014) include 'standardised' and 'non-standardised' interviews, though the latter termed these 'structured' and 'non-structured' interviews. McLeod also added the third category of interviews termed as 'focus group interviews'. Contrary to the categories provided by these writers, Patton (2002: 341-347) listed three general categories of interviews as 'the informal conversational interview, the general interview guide approach and the standardised open-ended interview'. Regardless of the terminology used to describe this technique, Harrell and Bradley (2009) argued that interviews are used for various reasons. These include among others, collation of primary data from individuals about their ways of living, views and beliefs as well as to obtain some background on specific targeted information. Of interest in this research was the general in-depth interview guide approach. This type provided options for the one-on-one and the one-to-many sessions between the author and the interview participants in this research. Interviews were used mainly to address the second objective, regarding the exploration of views on the current regime.

Interviews were used to solicit views, practices, beliefs or opinions of the respondents, hence assisting in the compilation of findings presented in Chapter Six. They also allowed the author to obtain data from experts in the green transportation field, which partly assisted in the compilation of the background chapter. Interviews also provided direction for finding other critical information and policy provisions the author was not aware of at the time. Hence, they assisted in addressing the first objective which evaluated the Government legislative and incentive regime governing transport greening in South Africa. Interviews also assisted with "snowballing" other potential interviewees who were later approached and interviewed. Initially, two separate guides were developed: a semi-structured one targeting mid-management (Deputy-levels) officials and an open-ended one designed for senior officials (Director-level and above). Officials and other high ranking individuals, according to Harrell and Bradley (2009), are unlikely to respond to a long structured interview schedule due to various reasons including time constraints. During the actual research, however, the initial plan of using a separate interview schedule for mid-management and senior officials was changed, with only one in-depth interview guide used irrespective of the rank of officials (Appendix B). This latter guide included ten open-ended questions used to guide the discussions during the one-on-one meetings with these officials. The same interview guide was used in interviews with non-government industry representatives. The use of a single guide was done to ensure consistency, and to get in-depth understanding of the type of responses to similar questions, rather than to different questions. One could compare and contrast responses from participants regarding different policy mandates, thus allowing exploration of underlying world views held in these institutions. On the industry side, one could see the feedback on the type of transport greening policies sought. While the guide was there, the respondents were however encouraged to say as much as they could on any given question, with little to no interference on the part of the author unless elaboration was required.

Government and industry institutions participated in the in-depth interviews, with the sample size presented in Table 4.2. This indicates the total number of respondents directly interviewed compared to the targeted sample size. Their particulars are provided in sub-section 9.4 of the reference list. To protect their identity, only pseudonyms are used, with their designations, actual interview dates and their organisations disclosed. Specific departments in Government as well as industry institutions were purposively sampled due to their mandates' or functions' proximity to the transport industry/ greening work. Their views were hence deemed crucial in the context of systems thinking presented in Chapter Three. Also, the reason for purposively targeting mid-senior management employees was to get a diversity of opinions and facts. It was believed that officials at mid-management levels are knowledgeable in terms of both technical and policy information, and often get exposure to transport greening related events/ forums which senior officials do not always participate in. These are officials at Deputy-Director level as depicted in Figure 4.2. Targeting them therefore would help in obtaining data-rich information. Senior officials (largely from Director level upward) possessed high level data, which was also critical for the research, especially to understand policy direction and possible reasons for certain worldviews held by the institutions they represented.

Table 4.2: Targeted interview participants versus actual number of people interviewed (by author)

Name of Institution	Targeted participants	Actual participants
Government	20 (10 Directors and 10 Deputy directors)	14 (7 Directors and 7 Deputy directors)
Industry	3 representatives	3 representatives
Total	23	17

While Government representatives were purposively chosen based on both rank and the immediacy of their departmental functions to transport greening, the situation was not that different with industry representatives. Industry representatives were also selected based on the linkages between their activities and transport greening efforts. They were spread to cover three sub-sector (internal combustion engines, electric vehicles and gas) players. A number of issues in qualitative research, according to Mason (2010), can affect sample size. The guiding principle however is data saturation, an issue, which according to this writer has been discussed extensively in the research fraternity, however with no consensus reached. Mason reviewed over 500 PhD studies that adopted a qualitative approach, with the result revealing a mean sample size of around 31 used in these studies.

If the average size in terms of Mason's 2010 study was 31 respondents, then 17 respondents in the case of research under discussion may indicate some sampling flaws in the interview process. Nonetheless, Mason (2010) argued that in qualitative research, the major determining factor regarding sample size is saturation. In this research, it was indeed difficult to tell whether saturation had been reached or not. The author had wished to continue interviewing more respondents to at least the average target number of 31 respondents, as suggested in Mason's study. Research constraints described in section 4.4 were, however, ultimately the main determining factor in the final size of sample. This section describes the process used to address the constraints. It also relates to sub-section 4.3.3, which describes the data triangulation technique used to mitigate against sample size deficiency, a tool that relates to the participant and direct observation techniques discussed in the following sub-section.

4.3.1.2. Primary data using participant and direct observation techniques

As a technique, participant observation has been used in a variety of disciplines to collect data about events, people, processes and cultures. It remains relevant, however requiring creative decision making in terms of selection of appropriate settings, establishment and sustaining of trusting relationships, ethics, values, and politics, as well as record making (Jorgensen, 2015). Like other qualitative methods of data collection, such as interviewing and document analysis, Kawulich (2005) noted that participant observation forms part of the umbrella term of "ethnographic methods". Ethnography was introduced in sub-section 4.2.3.1, where Sangasubana (2011) noted that researchers using this strategy, immerse themselves in the daily activities of the subjects being studied. This has implications for the axiology philosophy described in Saunders et al. (2009) as alluded to earlier in the chapter, where a researcher's own value system and how the researcher manages this, becomes important.

As a way of gathering the data in this research, the author took notes, recording the discussions on and participants' engagement with green transport related matters. As noted in Kabir (2016), this technique is fundamental when conducting either structured or unstructured interviews. In this research, data was collected through direct participation in various events, and at times through the preparation of and delivering of presentations or participation as a panelist. Furthermore, the author (as explained in section 4.2) was, during the time of the research, serving full-time in Government, in a green economy-related portfolio, specifically transport sector greening. Due to his immersed participation, the author's values and views were indeed part of the process. As much as the author's own feelings about the what, how, why and when of green transportation were part of the process, by listening carefully and examining various viewpoints, the author tried to remain as neutral as possible. Deficiencies in the primary data were counterbalanced by use of secondary data, which is the focus of the following sub-section.

Participant observation was used to address all three objectives introduced in Chapter One. The author participated in various multi stakeholder groups/ fora and workshops that aimed at addressing green transport related issues in South Africa. This includes attendance of over ten events listed in Appendix E. The worldviews of participants observed revealed drivers in transport greening introduced in Chapter Two (the green economy quandary). In these events, people expressed their worldviews in various ways including verbal arguments in discussions as well as driving of specific vehicles, such as EVs. These "messages" contributed to deeper understanding. Participants in these events included Government officials whose views and behaviour reflected either departmental or their own personal worldviews.

Jorgensen (2015) regarded participant observation as a unique method that allows researchers to interact with people in everyday life while collecting information. It enables researchers to examine complex, diverse and rich experiences, thoughts, feelings, and activities of human beings. As a participant observer in the various events mentioned above, the author was continually gaining an insider's view of reality, which ranged from the author's department to sister departments with related transport sector greening mandates. The author was also able to obtain inside information from industry experts and representatives in various events and meetings, most of which were official. Also, the author was part of decision making processes and had an opportunity to observe on a regular basis, decisions being made by various departments. Research notes were taken to record key emerging issues crucial to the research aim and objectives. Marshall (2006) noted that even in investigations that use in-depth interviews as primary data collection tools, direct observation is still critically important. This allows the researcher to observe participants' body language in addition to what they say in spoken words (Marshall, 2006). Kabir (2016) noted that interview participants can paint a picture of what happened in a particular event not only through their verbal responses but via other social cues (including voice, tone, body language etc.). In this research, data collected using observation techniques were thus used to supplement data collected through document reviews and the semi-structured interview guide discussed in subsequent paragraphs.

4.3.2. Secondary data collection

The study used numerous types of documents including journal articles, textbooks, PowerPoint presentations, Government official reports and research documents by Government and other institutions, newspaper articles, as well as policy and legislative documents from Government gazettes. Secondary sources (see Table 4.3 for a summary) include 44 documents on SA policy and legislative frameworks, 15 documents on SA official reports/ documents and 14 documents on international legislative and policy frameworks. The decision on which document to review was based on literature review and was guided by the six research themes depicted in Figure 4.4. These themes, as discussed in Chapter Two, feature prominently in the sustainable transportation literature, and hence provided ideas on which information to aim for and extract from such data sources. The themes are in line with the green transportation pyramid (Figure 2.1 adapted from Urban Hub, 2020) and the A-S-I model (Figure 2.2 adapted from Deutsche Gesellschaft für Internationale Zusammenarbeit (giz) GmbH, 2016), both introduced in Chapter Two.

While some documents were obtained from libraries, the majority of these documents were sourced online, addressing issues at local, provincial, national and international levels. They included documents on environmental protection, energy generation and planning, transport planning, economic development, industrial development, health, science and technology, finance, etc. They also covered issues pertaining to conceptual frameworks as well as the research philosophical and practical aspects, which all guided the research process. The secondary documents were used to compile most chapters including the literature review, conceptual framework, background as well as the methodology and research design chapters. They were also used to address all three objectives covered in Chapters Five, Six and Seven, respectively. Policy documents were used mainly to address the first and third objectives (Chapters Five and Seven), while official reports were used primarily to complement data collected through in-depth interviews and participant observation, hence addressing the second objective covered in Chapter Six. The official reports are listed in sub-section 9.5 of the reference list.

Table 4.3: Secondary data sources (by author)

Data sources	No. of documents	Objective addressed
SA legislative and policy documents	Over 40	First and third objectives/ Chapter 5 and 7
SA official reports/ documents	15	Second objective/ Chapter 6- supplements interview data in Table 4.1
International legislative and policy documents	14	Third objective/ Chapter 7
Total	73	

The South African legislative documents reviewed are listed in sub-section 9.2 of the references section, with the international legislative and policy documents examined, also listed in sub-section 9.3 of the reference list. In addition to these documents, a further 300 documents were also used to compile the background, literature review, theoretical framework review and methodology chapters. This literature is also referred to from time to time, in the findings chapters to support the arguments. These documents are listed in sub-section 9.1 of the reference list.

4.3.3. Data validity and use of triangulation

To improve the validity of data used in this research, the author used several types of data, collected using different tools, as discussed in the preceding sub-section. In the terminology used by Patton (1999), this could be referred to as data triangulation. Treharne and Rigg (2014) noted that the primary purpose of this technique is comparison of different types or sources of data to explore convergences, complementarities and dissonances. It is not designed to confirm the validity of the data, but instead to record various elements of the phenomenon being studied. This is based on the notion that, multiple methods allow one to uncover different aspects of the same topic being investigated, and as such, they are capable of providing more insight.

In this research, these methods included use of primary and secondary data collection and analysis tools. It was believed that such an approach would reduce vulnerability to errors, compared to when a single method is used. An example of how successful this technique was can be noted in the analysis of the code/ category pertaining to the over-subsidisation of the transport sector status quo in South Africa. This trend appeared a number of times as presented in Chapter Five, following thorough analysis of policy documents using the document analysis techniques. It was also reported several times by the interview participants as discussed in Chapter Six. The correlation between the in-depth interviews and the findings from data collected using document review are evidence of triangulation as a quality check/ improvement technique. This repeated appearance of similar data from the use of multiple collection tools addresses the theoretical saturation concerns alluded to in sub-section 4.3.1.1 as a result of a smaller than planned in-depth interview sample of 17 people.

4.3.4. Data analysis, interpretation and presentation

From the discussion in the preceding sub-sections, three types of data used included responses from in-depth interviews, the review of documents as well as direct observation. These required different types of data analysis techniques. This is qualitative data which, according to Folkestad (2008), presents a great challenge during the analysis stage, given the lack of well-designed techniques to analyse the data. Meurer (2007) also noted that qualitative data are obtained from a relatively small group of respondents and are not analysed statistically. The analysis hence involves detailed verbal description of characteristics, cases and settings. While quantitative data are best analysed through mathematics and statistics, qualitative data are better analysed through conceptualisation (Dey, 1993).

Folkestad (2008) presented four major paradigms in qualitative data analysis: naturalistic/positivism, ethnomethodology/ constructionism, emotionalism and post modernism paradigms. This research argues that as they guide data collection, so they should also guide the manner in which such data are analysed. These paradigms, according to Folkestad (2008), offer some clear guidelines for analysing data. Embedded within the naturalistic paradigm is a content analysis technique. Hsieh and Shannon (2005) argued that while other techniques exist to analyse qualitative data, content analysis offers many benefits, as shown in the sub-sections that follow.

4.3.4.1. Content analysis to analyse primary (interview) data and official reports

This technique was used to provide response on the second objective of this research, read as follows: *Exploration of views on the current regime relating to transport sector greening and explaining the desired policy direction.* Hsieh and Shannon (2005) traced use of this technique as follows: 97 studies in 1991; 332 studies in 1997 and 601 studies in 2002. They consider this technique flexible, as it is able to analyse data available in various formats. The current study used data collected from a diversity of primary and secondary sources as described in the preceding sub-sections. The first step in the analysis of such data involved data transcription explained next.

4.3.4.1.1. Data transcription

Interview data that had been recorded on hard paper during the interviews was later rewritten and transformed into electronic versions using a word processor. Electronic documents were in Word or Power Point format or Portable Document Format (PDF), especially the official reports from various proceedings including the South African Competition Commission’s enquiry into this country’s transport sector competitiveness. When all the data was in an electronic format, it was coded as described in the steps presented in the following sub-section. During this process, the author was looking specifically for any data that represented views on Government performance in implementing mechanisms aimed at promoting green transportation within the context of six categories introduced in Chapter Five. The categories included cleaner fuels, fuel economy, alternative vehicles, alternative fuels, modal shift and non-motorised transport. The data sought also included respondents’ understanding of the transport greening drivers in South Africa, including views on Government performance on the development of support tools that have been used successfully in major green transportation countries.

4.3.4.1.2. Data coding and categorisation

Coding usually involves sorting of data, words, phrases and concepts, arranging them into groups of similar meanings (Stuckey, 2015 and TRIED 3, 2016). The Center for Evaluation and Research, UC Davis (2012) regarded coding as analysis, where such codes can be ‘pre-set’ (‘priori codes’) based on the review of literature and conceptual framework. One’s experience with the issue under investigation assists the process of creating such codes. This implies the adoption of a deductive approach introduced in the previous sections of this chapter. The researcher can also use the data collected to generate new codes, coming up with what is commonly known as 'emergent codes'. With these two methods of generating codes, the Center for Evaluation and Research, UC Davis (2012), therefore recommended a hybrid approach, where the rule of thumb should rather be to *'make codes fit the data'*, as opposed to doing the opposite.

The data coding and categorisation scheme adopted in this research is portrayed in Figure 4.3. What this figure shows is a coding scheme that was done manually without any use of sophisticated qualitative data analysis software, even though AtlasTi software had initially been identified as a possible tool. The use of computer-assisted techniques can, according to Meurer (2007), improve procedure standardisation, permitting greater flexibility in revising the analysis process. Software, according to Marying (2014), also serves as an assistant to the researcher, providing a documentation centre of the analysis, under certain circumstances preparing the results of analysis for further quantitative processing. Despite the existence of such software, according to Stuckey (2015), the coding process remains the same, with the researcher having to do this and the software only assisting the researcher to manage the data. In this research, following Stuckey, coding was done manually.

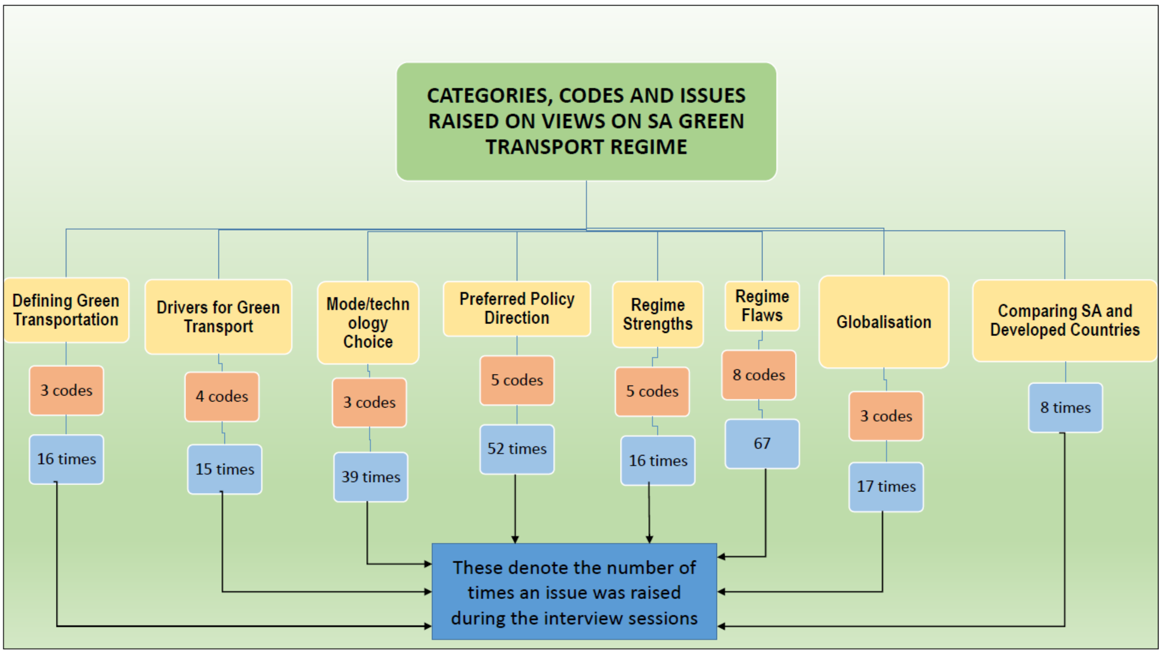

Figure 4.3: The interview data coding scheme (source: author)

Starting with one interview script chosen randomly, each script (17 in-depth interviews) as well as 15 official documents were each read twice or more until codes were identified in phrase, word or short sentence formats. The process involved extracting text that portrayed respondents' views on those transport greening topics alluded to in sub-section 4.3.4.1.1. This was done until no newer codes could be identified. Coding provided what looks like a hierarchical scheme, with main codes and sub-codes. As the process progressed, the coding scheme was refined, with new codes being added and others collapsed. At the end, a total of 31 codes was developed, excluding eight major codes which were later used to form major categories which were classified into sub-codes. Most codes in the coding scheme were a priori codes since they had been informed by the content of the in-depth interview guide. This guide (Appendix B) had been designed based on literature and a conceptual framework review and the author's prior knowledge of issues pertaining to South Africa's efforts to green the transport sector.

All in-depth interview scripts as well as official reports were read, with issues now cut and pasted under each of the major eight categories, leading to a total of about 230 issues (codes) which were fitted under these major categories. The major categories are presented in the introduction to Chapter Six, notably Figure 6.1. The sub-codes are presented in various sections of that chapter. By virtue of this research using mainly a priori codes, the research could be deemed to have adopted a descriptive strategy as a dominant form of enquiry. As such it provided a status quo description of green transportation policy and legislative provisions, as well as stakeholder views on the status quo in South Africa. Nonetheless, these were not merely the descriptions of the 'what' aspects of transport greening. These were accompanied by a series of detailed explanations of the status quo hence contributing to answering certain 'why' questions linked to the country's transport greening regime, in the process either validating or refuting various conceptual constructs. While the descriptions were informed by certain conceptual underpinnings, further new concepts emerged from the discussions and are discussed in Chapter 7.

4.3.4.2. Data presentation using verbatim

The study adopted two techniques of presenting data from the interviews – the quote technique/ verbatim as well as Tables, Graphs and Figures. The author could not find a set of rules regarding the number of quotes to be used in the document. The only rule of thumb was related to the need to ensure that the researcher's interpretation of data is not done at the expense of participants' quotes. Too much of a researcher's own interpretation, with less to no verbatim, according to Marrow (2005), tends to leave readers in doubt as to the origin of the interpretations. While welcoming the use of respondents' quotes, Marrow however cautioned about excess use of quotes as this can 'cause the reader to become lost in the morass of stories' (Marrow, 2005: 256).

In the current research verbatim was used as deemed necessary. To avoid using this technique as the only data analysis and presentation method, however, data unitising and categorisation techniques were also used. To illustrate certain points, figures and tables sourced from other secondary sources, were also used. With coded and categorised data, graphs and tables were later produced to illustrate the interpretations. While this was not an attempt to reduce qualitative data into quantitative (literature often warns against this), it was believed that this research can be considered to have adopted a mixed approach as alluded to in sub-section 4.2.2. By using verbatim in this research, it was also believed that readers would get a glimpse of the truth, hence providing transparency and credible results.

4.3.4.3. Document analysis to analyse legislative, regulatory and policy documents

Bowen (2009) noted that the researcher should not necessarily treat information contained in documents as facts. Instead, the researcher has to explore the content of such documents by finding, selecting, appraising and synthesising the data contained in documents. This involves extracting the data, excerpts, quotations or entire passages that are then organised into major themes, categories, and case examples specifically through content analysis (TRIED 3, 2016). Document analysis was used in this research to analyse legislative, regulatory and policy data from the South African and international government regimes. Similar to the manner that South Africa's secondary data documents were selected as discussed in sub-section 4.3.2, the selection of international policy documents to review was guided by the six (6) research themes/categories depicted in Figure 4.4.

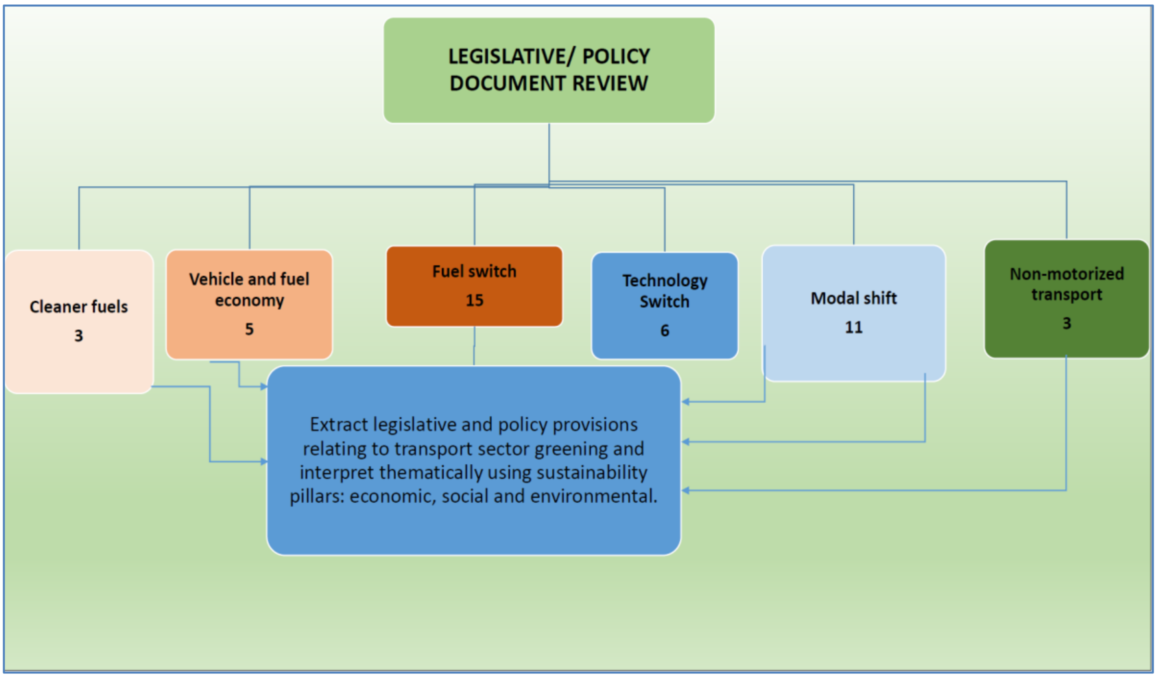

Figure 4.4: Document review flow diagram (source: author)

The decision on specific regions and countries was driven by the existence of literature on the progress and experiences of these countries in various transport greening activities. A total of over 40 South African and 14 international policy documents were reviewed. These are listed in sub-sections 9.2 and 9.3, respectively. This technique was used in conjunction with participant observation and in-depth interview analysis techniques already discussed in the subsequent sections. These categories feature prominently in the green/ sustainable transportation literature presented in Chapter Two and hence provided guidance on which information to extract from policy documents. The numbers below each category refer to the number of policy documents reviewed under that category.

The categories shown in Figure 4.4 are in line with the green transportation pyramid and the Avoid, Shift and Improve (A-S-I) model discussed in Chapter Two, and to a certain extent in the GTS (DoT, 2018) and DoE (2011) discussed in Chapter Five. Six categories were hence used in arranging the information and presenting the data in the subsequent chapters. By virtue of the third objective of this research comparing South Africa with other international country players, the six categories depicted in Figure 4.4 were used to provide such comparative analysis. The meanings of these categories are all defined under the '*DEFINITIONS OF KEY TERMS'* provided in the title pages. While this research was accomplished within the University of South Africa's prescribed study periods for PhD studies, a number of hiccups were encountered during the process. These glitches as well as the manner they were addressed, are briefly discussed in the next section.

4.4. RESEARCH LIMITATIONS AND HOW THEY WERE ADDRESSED

It is acknowledged in this thesis that green transportation encompasses more than the themes/ categories depicted in Figure 4.4. This research therefore excluded other policy aspects of a transition to a greener transportation regime. These aspects include civil engineering-related policies with regard to the type of material used and processes followed during the construction of roads, freeways and bridges. The research also excluded the review of policies related to land use change, travel demand management and integrated transport planning. The research was further limited to road transport, hence excluding the marine and aviation sectors. These exclusions helped in reducing the scope, and are highlighted in Chapter 8 as areas that require further research.

In the university approved proposal there was a minimum target of 23 individuals to be approached for direct face to face open-ended in-depth interviews. A maximum of 34-40 individuals had been targeted, taking into account the snowball effect. Due to non-responses and respondent last minute cancellation of interview schedules, only 17 individuals were interviewed directly. Representatives from some key departments, notably the Department of Energy, could not be interviewed as no permission letters were obtained from their gatekeepers. The University's approved ethical clearance (discussed in the next section and attached in Appendix A) made it clear that no research should be conducted with the departments where the necessary approvals had not been granted. Furthermore, respondents at targeted metropolitan municipalities could not be interviewed despite several attempts and follow-ups to secure the interview dates. With the time frame of less than 36 months to complete the research, the project continued, with these deficiencies counteracted as discussed in the next paragraph.

One way to counteract the deficiencies was to attend events and be a participant observer where representatives of the 'unreachable' municipalities and departments were present.

The list of events attended are included in Appendix E. The second option involved examination of secondary data, where officials from these institutions had attended and either made comments, delivered speeches or made presentations. The list of official documents reviewed are included in the reference list. In this way, the policy positions, views and concerns of these institutions/ individuals within these institutions, with respect to the research topic, were gathered. In attending such events, the author took notes, while at the same time participating in and observing the proceedings. These events helped considerably to counteract loses experienced from the challenges mentioned above. As a participant observer in these real life events, the author was able to collect the data, which became useful during the later stages of data analysis.

In addition, the review of presentations delivered at these events helped to counterbalance failed attempts to meet with municipal officials. These sessions had taken place in all three targeted provinces of Western Cape, KwaZulu-Natal and Gauteng. In these enquiries, officials for the targeted metropolitan municipalities of Durban, Cape Town and Johannesburg made presentations, which presented municipal viewpoints on transport related issues, including transport greening. These presentations, as noted in the preceding section, were hence coded and categorised accordingly.

4.5. ETHICAL CONSIDERATIONS

In conducting this study, respect was continually kept in mind and the moral principles and the general ethical principles of the University of South Africa were upheld at all times. Since the research involved interaction with human subjects, it was a requirement that ethical approval be obtained prior to commencement with data collection. The University's Ethics Review Committee offered this approval in late 2016 (Appendix A). The approval letter had clear terms and conditions, including that no research could commence with institutions that had not offered permission letters. While the author understands the rationale for this, it is the author's view that this hinders academic freedom. It gives considerable power to gatekeepers to the detriment of the research process, especially in institutions that do not have clear rules as to how requests to conduct research within their premises are handled. Accessing gatekeepers in certain institutions was one of the challenges in this research. An appeal for flexibility in the conditions of ethics approvals is therefore made in this case.

Nonetheless, the researcher obtained permission to conduct the research in a number of institutions whose representatives were interviewed. The select number of permission letters are listed in Appendix F, with interview scripts listed in Appendix C. This was made possible by a slight adjustment to the researcher's initial strategy. Initially it must be noted that the accounting officers (i.e. the highest ranking officials such as Heads of Departments or Director-generals) in the case of Government, had been approached directly, requesting permission to conduct research within their institutions (permission letters issued by the national Department of Trade and Industries and National Treasury are such examples). The delays in this process called for a change in plan, with heads of specific units (mainly senior managers) in the departments then approached. These would then handle the request themselves or delegate others to meet with the author. Typical examples of this were the permissions from the departments of Environmental Affairs and Science and Technology.

For other institutions, direct meetings with identified representatives had not necessitated prior permissions from gatekeepers. This includes industry representatives as well as some Government agencies. All requests for interviews were made through formal invitation letters where all ethical considerations had been observed including the signing of consent forms, the purpose of research and associated implications to the respondent's participation. No minors were involved nor any sensitive information that required clearance in terms of the institutions approached. Nonetheless, in the case of Government officials, all those who were interviewed (as a standard practice in Government) are subjected to security clearance. It is the author's belief that they had prior knowledge of boundaries in terms of what information to divulge and what not to divulge. Thus, in addition to the gatekeeper approvals received from their institutions, they also had sufficient security to cover themselves in the case of any threatening issues that may have been raised. To further protect their identities and encourage genuine participation, this research does not mention real names of those participants who provided primary in-depth interview data.

When information has been extracted from secondary data sources such as official reports, specific names may at times appear, especially if the document referred to is already in the public domain. No tape recorders nor video recorders were used. Participants were informed about their rights – see a copy of consent form (example) in the list of appendices. The interview transcripts were not shared with anyone and were saved in very strictly encrypted files and folders to minimise exposure in the event of unintended consequences such as invasion of the author's system, hardware loss, etc. Throughout the research process, efforts were also made to ensure that the work of others was acknowledged. The entire thesis report was also subjected to document originality checks to ensure compliance with the University's plagiarism rules. The result of the compliant similarity index is also attached in the appendices.

4.6. CONCLUSION

The research process followed in this study can be summarised in Figure 4.5 below, which breaks down the process into three major themes: the research philosophy, research approach and research design.

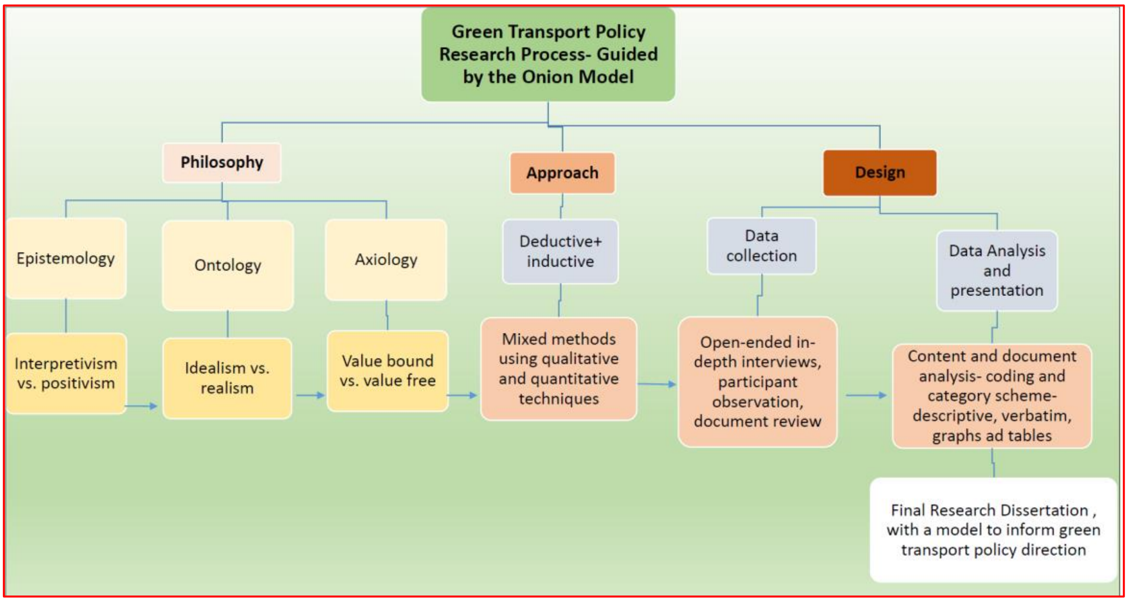

Figure 4.5: Summary of research process flow (source: author)

The research process followed a philosophy that includes interpretivism epistemology, idealism ontology as well as axiology leaning towards the value bound system as opposed to a value free system, since the author was part of the phenomena being studied. A mixed research approach was adopted (involving the use of qualitative and quantitative techniques in data collection and analysis). The entire process was, however, dominated by a qualitative approach which, as explained in the chapter, is usually associated with inductive approaches, where the ultimate goal is usually theory generation. With the mixed approach adopted in the research, the ultimate product is a hybrid/ mixture of theory explanation/description/ refute and theory generation. This is in line with the research design as it employed qualitative forms of data collection and analysis. The research was not without constraints, which were also discussed in this chapter.

The next chapter, as the first of three which present the results of this research, provides a critical review of South Africa’s policy, regulatory and legislative framework.

CHAPTER FIVE

RESULTS ON CRITICAL REVIEW OF SOUTH AFRICA'S POLICY, REGULATORY AND LEGISLATIVE FRAMEWORK

5.1. INTRODUCTION

As described in Chapter Four (Methodology and Design), data presented in this chapter were obtained from secondary sources and comprise regulatory, legislative and policy documents available from official websites and other archival sources of several government departments. This is the kind of data which, according to Hox and Boeige (2005), had originally been collected for a different purpose other than that of research at any given point in time. The idea here is to describe transport greening ideologies and practices featured in these government tools. The fact that this research sought to provide understanding of Government responses to green transportation leads to questions that are central to interventionist theories, especially the question relating to the requirements for sustainability of an intervention as described in Argyris (1970). Two options available to governments are either to intervene as a way of correcting market failures or simply to allow the transport industry to self-regulate. When Government intervenes in a relationship between those who are supplying and those who are demanding transport goods and services, such intervention is usually associated with an attempt to address a particular problem. In the case of transport sector greening, this could be pollution, climate change or any other factor that is socially, economically or politically motivated.

This chapter examines efforts related to greening transport and hence covers issues pertaining to the economic, social and environmental pillars of sustainable development. It presents the status quo in terms of policy, regulatory and legislative frameworks and describes fiscal instruments such as taxation, subsidies and other forms of investments in green transport initiatives. The discussion hence places itself within the context of environmental Keynesianism debates introduced in Chapter Three, notably the arguments by Blackwater (2012). This writer called for state spending on 'green' objectives as a way of simultaneously rescuing the economy from recession and the planet from destruction. The chapter thus demonstrates a strong connection between interventionist theories and sustainability theories introduced in Chapter Three. The latter assisted in raising questions on the 'why' aspects of transport greening, hence contributing new knowledge presented in Chapter Seven. The intervention should result in something explainable using the X and Y (cause and effect) relationship discussed in Woodward (2009) and Reutlinger (2013). In this case, Government becomes a manipulator, with the transport system being the manipulated. The South African Government is indeed an organisation with many parts in the form of organs of state expected to function according to the provisions in the country's supreme law, the Constitution (Act No. 108 of 1996). Chapter Three of the Constitution makes provisions for co-operative governance between the state organs when dealing with issues of national interest. In developing regulatory and policy frameworks presented in this chapter, Government ought to operate with these principles in mind, meaning that there is one government system. These are closely aligned to critical realism-based systems theories introduced in Danermark et al. (2002) and Sayer (2000). By adding the third sphere of governance (the international community), globalisation theories explained in Robinson (2007) could not be ignored as they provide a powerful tool to explain South Africa-world relationships in transport sector greening. In other words, as much as there is one government system in South Africa, this country is also part of a global system which has a particular influence on decisions made in this country. This chapter draws lessons from systems theories to explore the event, patterns and underlying structures beneath the iceberg in the model introduced by North West Institute (2017) in Chapter Three. While these patterns and structures may be of local origin, global influence cannot be ignored. By virtue of this chapter providing a critical review of the South African regime, all four theoretical frameworks introduced in Chapter Three (interventionist, systems, sustainable development and globalisation theories) are therefore applicable and the findings presented should be interpreted within this context.

The chapter is divided into nine sections including the current section. The next section provides a brief synopsis of the precursor of the country's green thinking in post-apartheid South Africa – the Constitution of the Republic of South Africa. While environmental provisions existed prior to this Act, namely, the Environment Conservation Act (Act No. 73 of 1989), the context was different. The Constitution had implications for all sustainability/ green thinking in subsequent legislative and policy documents evaluated in this chapter. One such document is the principal environmental legislation, the National Environmental Management Act [NEMA] (Act No.107 of 1998) which is also briefly introduced in this section. There is a strong link between the Constitution and this principal environmental legislation. Another recently developed policy framework that links directly to green transportation is the Green Transport Strategy (GTS) which is also introduced in section 5.2. This broad policy document covers some of the six broader categories used in guiding policy evaluation in this chapter. Shown in Table 5.1, these categories were used as a way of classifying various interventions aimed at greening South Africa's transportation sector, and are presented from section 5.3 to 5.8 in the order they appear in Table 5.1. The categories were deemed to be core as they feature prominently in the green transportation literature and hence provided guidance on which information to extract from policy documents. They are in line with the green transportation pyramid introduced in Chapter Two and the Avoid, Shift and Improve (A-S-I) model discussed in the same chapter and to a certain extent, in the GTS (DoT, 2018) as well as DoE (2011). The same categories are used in arranging the information and presenting the data in the subsequent chapters, especially Chapter Seven which provides more discussion on the findings.

Table 5.1: Green transportation categories (by author using information obtained from GIZ, 2016; Urban Hub, 2020; DoT, 2018 and DoE, 2011).

Green transportation category	Policy parameters examined
Cleaner fuels	Fuel quality standards – self vs forced regulation, abolishment of lead, reduction of and rationale
Fuel economy	Automotive standards – self vs forced regulation, international forces
Technology switch	Electric vehicles: BEVs, PHEVs and HEVs; dual fuel vehicles, compressed gas power vehicles and biofuel powered vehicles
Fuel switch	Alternative fuels including biofuels, compressed natural gas and hydrogen fuel cells
Modal shift	Road to rail (Gautrain, Metrorail, trams, private to public transport (possible modes: Bus Rapid Transit (BRT), E-toll implications, minibus-taxis, vehicle sharing schemes)
Non-motorised transport (NMT)	Cycling infrastructure, biking, walking lanes, donkey carts, etc.

The focus in this research was largely the national sphere of governance; however, with most implementation taking place at municipal levels, policy drivers at the municipal and provincial levels are also explored. Reference is made to four metropolitan cities located in the provinces of Gauteng, Western Cape and KwaZulu-Natal. A quick look at these metros necessitated a brief exploration of work at provincial levels.

5.2. SOUTH AFRICA'S CONSTITUTION AND IMPLICATIONS FOR SUBSEQUENT GREENING LEGISLATIVE AND POLICY FRAMEWORKS

In 2010, the United Nations Environment Programme (ENEP) published the Compendium of South African Environmental Legislation. In this compendium, Van der Linde and Feris (2010) noted that various regulatory norms relating to environmental protection and management can be traced back as early as the 1940s, including the Environment Conservation Act (Act No. 73 of 1989). The promulgation of the Constitution, however, changed things for the better, as it set the foundation of green thinking moving forward. The previous environmental management legislation, according to Van der Linde and Feris (2010), was not adequate nor effective especially in dealing with issues of administration, governance, norm setting, enforcement and judicial action. The Constitution led to a series of environmental laws designed and promulgated specifically to uphold the rights entrenched in it. These include legislative frameworks in various thematic areas such as air quality; biodiversity, ocean and coastal management, environmental management; environmental impact assessment; waste management; mining; forestry; and water management. South Africa's legislative framework therefore comprises the Constitution (Act No. 108 of 1996) as the supreme law, Acts, Regulations as well as Norms and Standards.

Chapter Three of the Constitution requires that the legislative and executive authority of different spheres of Government operate within a framework of cooperative governance. Government is hence constituted as national, provincial and local spheres of government which are distinctive yet interdependent and interrelated. All spheres of government, according to this chapter, must therefore observe and adhere to the prescribed principles, conducting their activities within the parameters of Chapter Three of the Constitution. It sets specific principles with respect to co-operative governance and intergovernmental relations, requiring all spheres of government and organs of state to comply with these. It requires organs of state to:

> … perform their functions in a manner that does not encroach on the geographical, functional or institutional integrity of government in another sphere; and co-operate with one another in mutual trust and good faith by fostering friendly relations; assisting and supporting one another; informing one another of, and consulting one another on, matters of common interest; coordinating their actions and legislation with one another; adhering to agreed procedures; and avoiding legal proceedings against one another (Government Gazette, 1996: 1269).

This chapter of the Constitution hence presents a framework which can best be described within the prescripts of the systems approach to thinking introduced in Chapter Three of this thesis. Also, section 24 (the Bill of Rights) elevates the country's commitment to environmental protection and sustainable development, by stipulating the following:

> Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (Government Gazette, 1996: 1251-1253).

Section 24 seems to be purely environmental, hence driving the environmental pillar of the sustainable development framework introduced in Chapter Three. While this section places environmental protection at the forefront, it should however be noted that the same section stipulates that this protection should not occur at the cost of justifiable socio-economic development (Government Gazette, 1996: 1251-1253). This therefore calls for a certain level of balance between the environmental and the socio-economic pillars of development, the core principle in sustainability debates introduced in Chapter Three. Further to Section 24 of the Constitution, Chapter One of the National Environment Management Act (Act No. 107 of 1998) sets principles for National Environmental Management, which apply throughout the Republic to the actions of all organs of state that may significantly affect the environment. Amongst many principles stipulated in this chapter, the principle set in section 2 (2) makes this Act truly anthropocentric. It requires that environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably. Both section 24 in the Constitution and Chapter One of NEMA seem to have been founded on anthropocentric worldview foundations discussed in Chapter Three in that the protection of the environment is encouraged only when it serves human needs. There is no emphasis on protecting the environment for its intrinsic value, not even principles 2(3) and 4(a) which stipulate that development must be socially, environmentally and economically sustainable, requiring consideration of all relevant factors which it listed. Principle 4(b), on the other hand, adopts what looks like a systems approach to thinking, emphasising a need for development to ensure integrated environmental management, stipulating that:

> … all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option (Government Gazette No. 19519, 1998: 12).

Chapter Three of NEMA stipulates requirements for cooperative governance in environmental management, the same issue addressed in Chapter Three of the Constitution. NEMA however distinguishes between two types of government departments in terms of their responsibilities for environmental protection/ management, i.e. those listed in Schedule 1 and those listed in Schedule 2. Departments falling under Schedule 1 include those departments who exercise functions which may affect the environment. As a result, they are required to prepare an Environmental Implementation Plan (EIP), which should describe how they are going to address the impacts associated with their functions. The departments listed in Schedule 2 include those departments whose functions involve the management of the environment. These departments are required to prepare an Environmental Management Plan (EMP). The purpose of these plans is among others to co-ordinate and harmonise the environmental policies, plans, programmes and decisions of various national departments towards the promotion of and achievement of sustainable development and environmental protection.

5.2.1. Relevance of environmental legislation to transport greening.

As noted in the Government Gazette No. 19519 (1998), the Department of Transport is listed as a Schedule 1 department in NEMA. As such, it is required to prepare an EIP, the contents of which include the following:

- ❒ a description of policies, plans and programmes that may significantly affect the environment;
- ❒ a description of the manner in which the relevant national department or province will ensure that the policies, plans and programmes referred to in paragraph (a) will comply with the principles set out in section 2 as well as any national norms and standards as envisaged under section 146(2)(b)(i) of the Constitution and set out by the Minister, or by any other Minister, which have as their objective the achievement, promotion, and protection of the environment;

- a description of the manner in which the relevant national department or province will ensure that its functions are exercised so as to ensure compliance with relevant legislative provisions, including the principles set out in section 2, and any national norms and standards envisaged under section 146(2)(b)(i) of the Constitution and set out by the Minister, or by any other Minister, which have as their objective the achievement, promotion, and protection of the environment; and),
- recommendations for the promotion of the objectives and plans for the implementation of the procedures and regulations referred to in Chapter 5 (Government Gazette No. 19519, 1998: 22-24).

Reasons associated with the Department of Transport's inclusion could be linked to the transport sector's contribution to air quality, climate change and other socio-economic impacts discussed in Chapter Two. With the transport sector cutting across mandates of three spheres of governance, and as noted in the Government Gazette (1996), the country's Constitution identifies the legislative responsibilities of these spheres. At national level, public entities, with specific delivery mandates, execute most transport related functions. The Department of Transport oversees the entities, conducts sector research, and formulates the policy, regulatory and legislative frameworks (DoT, 2018). As such, it sets the strategic direction of transportation sub-sectors, at both provincial and municipal levels, while also monitoring the implementation of various transport related programmes.

Any efforts to ensure a safe, cost-effective, affordable, environmentally friendly and efficient transportation system, however, requires efforts beyond the mandate of the Department of Transport. As an example, a vehicle without fuel is like computer hardware without a software. Both the software and the hardware have to be updated from time to time, to keep up with technological developments and moving times. Hence, vehicle technology that was once considered efficient and 'breakthrough' 20, 50 or 100 years ago, may not necessary be as efficient nowadays. This is the case with carbureted versus fuel injected vehicles, with the latter considered to be more fuel efficient. The transport sector is therefore clearly a multidisciplinary area, linking its work with the mandate of many other departments including those responsible for science and technology, energy, trade and industry, finance, environmental affairs and others. As presented in ERC (2013) and Walters (2014), greening the transport sector requires coordinated efforts, something which these writers noted is lacking in South Africa. Coordinated efforts are required to minimise clashes in Constitutional mandates which are all enshrined in the country's supreme law. This, in principle, would mean compliance with a systems approach to thinking which, as discussed in Togo (2009), Sexton and Stanton (2016) and Environment and Ecology (2019), recognises that organisations are complex social systems. In such systems, the separation of parts from the whole system, reduces their overall effectiveness. These writers described the interrelated nature of various elements in a system, and when applied in the context of this research, the interrelatedness of a government system in the Republic of South Africa.

One policy document developed on the basis of this kind of approach is the Green Transport Strategy (GTS) discussed in the following section.

5.2.2. The Green Transport Strategy

The Green Transport Strategy (2018-2050) is the latest policy addition to the transport greening debates in South Africa, approved by Cabinet. In this strategy, the Department of Transport (2018) sets targets for the introduction of various green transport initiatives including a switch to greener automotive fuels and a switch to technologies such as electric vehicles. The mandate of this department is however:

- to lead the development of integrated efficient transport systems by creating a framework of sustainable policies, regulations and implementable models to support government strategies for economic, social and international development; and,
- to maximise the contribution of transport to the economic and social development goals by providing fully integrated transport operations and infrastructure (DoT, 2018: 09).

From these statements, this mandate is not necessarily environmental, but rather oriented towards transport planning. Through the spirit of working together or perhaps due to this department's EIP obligations as stated in Government Gazette No. 19519 (1998), this department has to be seen to be taking measures to address potential environmental impacts of its policies and programmes. The transport department's aspirations therefore are expressed through such initiatives as the Green Transport Strategy (GTS) whose objectives and drivers seem to be purely environmental. This can be seen from the following statement extracted from the GTS document:

> The Green Transport Strategy (GTS) serves as a guide to the DoT to implement a basket of measures that will significantly: reduce Green House Gas (GHG) emissions produced by the transport sector; reduce the environmental and human health impacts associated with the transport sector, resulting in a more resilient sector; reduce transport GHG emissions to contribute significantly to the national effort to decrease emissions as agreed to by the South African government at COP21 in Paris through the NDC (DoT, 2018: 22).

Due to its emphasis on climate change mitigation, it is tempting to argue that the GTS's intentions are purely environmental and specifically, climate change oriented. In the National Climate Change Response White Paper, the Department of Environmental Affairs (2011) included transport as one of the key Climate Change Flagship Programmes. Here, the Department of Transport was posed to facilitate the development and enhancement of public transport programme to promote lower-carbon mobility in selected localities. It was expected to create an Efficient Vehicles Programme with interventions that result in measurable improvements in the average efficiency of the South African vehicle fleet by 2020. This also included a need to roll out the rail re-capitalisation programme to facilitate modal shifts of both passenger and freight from road to rail. The programme would also enable this department to roll out measures to improve the efficiency of Government fleet by 2020. The flagship programme, according to Motsepe (2017), involved efforts to make available and accessible the integrated transport systems, prioritising the use of more efficient spatial design, transport networks and operations; low emissions transport modes, vehicles, fuels, technology; non-motorised transport; and climate-resilient infrastructure. DoT (2018:46) also noted that the GTS will be used as a mechanism to implement the Transport Flagships as identified in the National Climate Change Response White Paper developed by the Department of Environmental Affairs (2011).

The logic emerging from the discussion here is that the Department of Transport's responses to transport sector greening, are largely influenced by the mandate of the Department of Environmental Affairs. The implementation plan of the GTS also assigns different organs of state responsibilities for the implementation of various measures falling within their mandates, with DoT committing to prioritising projects for funding and implementation (DoT, 2018). How the Department of Transport plans to coordinate the implementation of these measures remains to be seen. Some of the implicated departments are only obliged to manage their functions through the EIP and EMP requirements of NEMA Chapter Three as discussed in the preceding paragraphs. They are expected to report directly to the Department of Environmental Affairs through a process legislated in this Act, as opposed to reporting to the Department of Transport.

Besides the GTS, transport sector greening in South Africa is currently promoted through various legislative provisions, which started a long time ago prior to the introduction of the GTS. It started from the development of policies and setting up of initiatives that sought to assist South Africa's migration towards the adoption of cleaner and less polluting transport fuels as discussed in the following section.

5.3. CLEANER FUEL POLICIES

By cleaner fuels in this section is meant liquid fuels (petrol and diesel) in South Africa, which are congruent with fuel specifications in Euro 2 and Euro 5 emission standards. The South Africa liquid fuel industry is very much dominated by fossil fuels either through the refining of imported crude oil and sale of finished petroleum products. Experts around the world, according to the South African Petroleum Industry Association (SAPIA, 2018), have over the past 30 years come to realise that cleaner fuels are a critical component of an effective clean air strategy. What exactly triggered the South African Government to pay attention on this issue? Did the Air Quality Act play a role? Chapter Eight of the Air Quality Act (Act No. 39 of 2004), specifically Section 53 (c), gives powers to the Minister of the Department of Environmental Affairs as well as provincial Members of Executive Committee (MECs) to make regulations prohibiting specific emissions from point, non-point and mobile sources. Section 26 specifically makes provisions for the control of "controlled fuels", while Section

23(1) refers to the control of "controlled emitters". In this case these officials may declare a substance or mixture of substances as controlled fuel. The use of such a mixture of substances may lead to the release of gaseous emissions, with potential negative effects on human health and ecological environments. The declared emitters known to the researcher include small boilers where the Department of Environmental Affairs (2013) set limits for sulphur dioxide levels as well as particulate matter content in the fuels used.

No known fuel has been declared as a controlled fuel in accordance with NEMA; instead, the national Department of Energy developed Regulations Regarding Petroleum Products Specifications and Standards (Gazette Notice No. 28958 of 23 June 2006). These were developed in accordance with provisions in the Petroleum Products Act, (Act No. 120 of 1977). The aim of this regulation was hence to recommend stringent conditions regarding the quality of fuel produced in South Africa. It aimed at reducing the levels of sulphur in both petrol and diesel, as well as reducing benzene and aromatic levels in petrol to levels equivalent to the Euro 5 emissions standard. This regulation led to the birth of the Clean Fuels Programme. Phase one of this programme (Clean Fuels 1/CF1) is discussed in the following sub-section.

With the CF1 programme, it looks like the Department of Energy did not want to wait for instruction from Environmental Affairs authorities to have transportation fuels declared in accordance with NEMA provisions. They rather became proactive and developed their own fuel greening regulations using the legislative framework under their mandate. The main trigger for the Clean Fuels Programme, according to a presentation by an official from the Department of Energy (DoE), however, seems to be related to the following considerations:

- ❒ The transport sector being a significant contributor to greenhouse gas emissions, hence prompting the DoE to tighten fuel specifications to reduce emissions from vehicles;
- ❒ Extending benefits to the motorists in the form of fuel efficiency and lower vehicle maintenance costs;
- ❒ Keeping abreast with global trends in vehicle technology in a manner supported by enabling fuels;
- ❒ Supporting Government's industrial development effort geared towards employment creation; and
- ❒ Promotion of international trade with emphasis on enabling the South African vehicle manufacturers to export technologically advanced vehicles to international markets (DoE, 2017).

These triggers seem to take into consideration all pillars of sustainable development, hence demonstrating a certain commitment to addressing the social, economic and environmental pillars of the sustainable development quandary. The approach of the Department of Energy also demonstrates a certain level of commitment to integration in Government policy making in a manner that highlights understanding of the multidisciplinary nature of transport sector greening. There is therefore evidence of efforts to comply with the systems approach to decision making, an approach which (as discussed in Chapter Three) may be deemed to be congruent with provisions in the country's supreme law. In 2008, the DoE started engaging various key stakeholders in the development of a Discussion Paper on the Review of Fuel Specifications and Standards (DoE, 2017). The consultation process involved many stakeholders including relevant government departments. It is a form of collaboration which, according to this department, culminated in the publication of the Discussion Document on the Review of Fuel Specifications and Standards on 8 March 2017. Table 5.2 further reveals the legislative framework designed to cause a paradigm shift from conventional fuels to clean fuels, at least at government level. Little to nothing is mentioned in these policy frameworks of the role that global influence plays in this shift to cleaner fuels. But what exactly was the influence of changes in Europe from Euro 1, 2, 3, 4, 5 and 6 standards? As noted in SAPIA (2018), even prior to Government taking an active role, the South African petroleum industry had already started embarking on fuel greening through the self-regulation approach as far back as 1986.

Table 5.2: Legislative framework driving the Cleaner Fuels Programme (by author)

<table>
<tr><th colspan="2">Policy name</th><th>Coverage</th><th>Driver</th><th>Date and source</th></tr>
<tr><td rowspan="2">Petroleum Products Act- 1977 (Act No. 120 of 1977)- Regulations regarding petroleum products specifications and standards

The two main policy players here were the Department of Minerals and Energy (later Energy) and the Department of Trade and Industries (the dti) through the South African Bureau of Standards (SABS)</td><td>Clean fuels I</td><td>Ban lead in petrol, but allowing other metals e.g. manganese and phosphorus in Lead Replacement Petrol (LRP) to cater for old vehicles who would suffer severe valve stem seal damage

Reduce diesel sulphur from 3000ppm to 500ppm, and to 50ppm</td><td>To improve air quality and perhaps reduce related diseases such as cancer and breathing problems associated with high-level of sulphur in fuel</td><td>2006 (Government Gazette Notice, 28958)</td></tr>
<tr><td>Clean Fuels II</td><td>Reduce the level of sulphur content in petrol and diesel to 10ppm, and removal of word 'manganese' in defining LRP.</td><td>To enable the introduction of cleaner vehicle technologies such as diesel particulate filters, catalytic converters and others.</td><td>(Discussion document- 08/03/2011; Draft document- 17/10/2011, then Gazette 9771 of 01/06/2012.</td></tr>
<tr><td colspan="5">In 2014, SABS finalised both the petrol and diesel Clean Fuels I and Clean Fuels II fuel specifications</td></tr>
</table>

The initial response according to the South African Petroleum Industry Association was reduction of lead levels in petrol from 0.836gPb/l to 0.60gPb/l in South Africa, followed by reduction of sulphur in diesel (5 500ppm to 3 000ppm in 2002) and in petrol (1 000ppm to 500ppm in 2005) (SAPIA, 2018). One of the biggest milestones, however, was the regulation of lead abolishment and further reduction in the sulphur content of fuel to lower levels through the Cleaner Fuels 1 and Cleaner Fuels 2 programmes as discussed in the following sub-sections.

5.3.1. The Clean Fuels 1 (CF1) Programme

The introduction of the CF1 programme in 2006 seems to have marked the beginning of an interventionist approach to fuel industry greening in the history of South Africa. It is a programme deemed similar to the Euro 2 standard regarding the amount of the following parameters in petrol and diesel. The exception is manganese in petrol and PAH[4] in diesel as shown below:

- ❒ Sulphur = 500 mg/kg (ppm)
- ❒ Aromatics= 50 (Vol %)
- ❒ Benzene = 5 (Vol %)
- ❒ RVP 45 – 75 ((kPa)
- ❒ Olefins=‘not specified’ (Vol %)
- ❒ Manganese= 36 (mg/liter). Not specified in Europe.
- ❒ Diesel sulphur 500 / 50[3] (mg/kg (ppm))
- ❒ Diesel PAH[4]= Not specified (% mass). Specified in Europe.
- ❒ Diesel Cetane Number= 45 (None) (Miller, 2019).

While the first six parameters apply to petrol, the last three parameters apply to diesel fuel. The CF1 programme involved two major activities, with the first being the reduction of sulphur content in diesel from 3000ppm to 500ppm and to 50ppm (DoE, 2017). The second activity involved the ban of lead in petrol. In order to cater for old vehicles which would suffer severe valve stem seal damage, other materials (manganese and phosphorus), were allowed to be used in Lead Replacement Petrol (LRP). Thirteen to fourteen years later, the “still dirty, but improved” Cleaner Fuel 1 grade LRP, still caters for such old vehicles. At the time of writing this thesis, this fuel grade was still available and sold at some of this country’s petroleum fuelling stations. In its pricing list, SAPIA (2020) also included this fuel grade. In June 2020, Engen South Africa (2020) was still keeping an advert, which highlighted the benefits of using LRP, and as such giving the impression that this company was still producing and supplying this fuel grade.

Despite the existence of LRP in South Africa, the volumes consumed have declined dramatically in the period 2007 to 2016 (DoE, 2017). In the same period, the market share for unleaded petrol (ULP) has gone up from 56% to 95%. Some fuel companies, such as

Shell, claim to have now removed this fuel grade in all of their fuelling stations (Shell South Africa, 2020). With the removal of this grade, Shell had advised vehicle users that, should their vehicles experience valve seat recession problems, they can simply use an anti-valve seat recession (ASVR) additive to their tanks every time they fill up with unleaded petrol (Shell, 2020). Shell claims that these additives provide similar protection to the protection that was provided by lead in leaded petrol. Another fuel retailer, TopUp (2018), reported a move similar to Shell's, where they stated that they also intend phasing out the LRP fuel grade in their filling stations.

Ultimately, the introduction of the CF1 programme raises many questions about South Africa's real intentions. It raises questions of whether such a policy response was purely a submission to international pressure or a result of real health implications associated with lead and sulphur emissions from exhaust gases at the time? SAPIA (2018) stated that after the implementation of CF1, there was improvement in emissions from diesel vehicles. It remains unclear, however, if the health status of people improved and if any studies had been conducted prior to the banning of lead in petrol and reduction of sulphur content to 500ppm and 50ppm, respectively. What is known, according to SAPIA (2018), is that many changes in South Africa needed to take place in the refineries in order to accommodate a paradigm shift to cleaner fuels. The transition led to fuel supply disruptions, with SAPIA calling for extreme caution in phasing in any new fuel specifications. To prevent similar supply disruptions that occurred from the first experience in 2006 when CF1 was introduced, lessons from that experience seem to have played a significant role in the slow pace of rolling out the new fuel specifications contained in the Cleaner Fuels 2 (CF2) programme, discussed in the next sub-section.

5.3.2. Transition to Clean Fuels 2 (CF2)

Based on the Petroleum Products Act (Act No.120 of 1977), the Discussion Document on the Review of Fuel Specifications and Standards for South Africa was gazetted by the Department of Energy in 2011. The gazetted document outlines the intended direction of Government towards further improvement in the quality of transport fuels. This includes a belief that, this country should allow itself to evolve from CF1 to CF2 (Department of Energy, 2011). While the Department of Energy claims CF1 to be equivalent to Euro 2 standards, Miller (2019) indicated the latter to be aligned with the European standard (Euro 5) hence requiring South African oil refineries to upgrade. Migration from CFI to CF2 involves the following changes regarding the quality of petrol and diesel sold in South Africa:

- ❒ Sulphur (mg/kg or ppm) from 500 to 10
- ❒ Aromatics (Vol %) from 50 to 35
- ❒ Benzene (Vol %) from 5 to 1
- ❒ RVP (kPa) from 45 – 75 to 45 – 65
- ❒ Olefins (Vol%) from 'not specified' to 18

- Manganese (mg/litre) from 36 to non-detectable
- Diesel sulphur (mg/kg (ppm) from 500 / 50[3] to 10
- Diesel P
- AH[4] (% mass) from Not specified to 11
- Diesel Cetane Number (no unit) from 45 to 51 (Miller, 2019).

While the first six bullet points apply to petrol fuel, the last three bullet points relate to diesel fuel. Unlike CF1 where the use of manganese was still permissible as a replacement for lead, in defining Lead Replacement Petrol (LRP) in CF2, the use of word ‘manganese’ was eliminated, altogether. The first date of operation of these provisions was set to be 1 July 2017, but this target date was never achieved (Miller, 2019). In June 2016, the Department of Energy gazetted amended regulations for cleaner fuels, indicating that the implementation date of July 2017 for CF2, would be rescinded and replaced with a date by notice in the gazette (SAPIA, 2016). SAPIA commended this move on the basis that, it would allow for more discussions regarding the financial compensation for refiners to effect the upgrades required to manufacture cleaner fuels. The development of CF2 standards and specifications was, nonetheless, another milestone for South Africa’s transition to the use of improved and comparatively environmentally friendly fuels in the country’s transportation industry. To accommodate the latest vehicle models in the absence of CF2, Mathews (2018) noted that South Africa imports all refined petroleum products needed for this purpose.

In the context of interventionist versus market driven approaches introduced in Chapter Three, the discussion in the preceding paragraphs becomes very important. The importance of Government intervention to rescue the economy (or to correct market failures) was highlighted in Chapter Three, notably the work of Blackwater (2012), Rietveld and Stough (2006) as well as the World Bank Public-Private-Partnership Legal Resource Center (2019). The discussion in this section however raises questions of the extent to which Government should intervene in the affairs of the fuel industry. This discussion is expanded in the next sub-section, where the Government’s role in the context of the CF2 programme, is subjected to more scrutiny.

5.3.3. Interventionists’ debates on the transition to CF2 programme

It has been almost eight years since the CF2 programmme was introduced in South Africa, but the standard is still not yet in operation. This is a delay which Miller (2019) and Mathews (2018) partly attributed to the long-standing negotiation between Government and industry on cost recovery mechanisms to fund the upgrade of South Africa’s oil refineries to migrate to CF2. In 2011, this cost was estimated at around R40 billion (Miller (2019). In an article published at the World Economic Forum, Pegler (2018) noted that the challenge that societies face is ensuring that the fuel produced does not pollute much, while at the same time being able to provide needed power. It is a challenge which, like many global issues, boils down to the economics. There are always costs involved and such costs are not trivial. Pegler (2018) noted that, while for those in the West, it seems obvious to simply apply the standards used there to others, western governments however worked together with industry and manufacturers to carefully manage how engines and machines responded to these new standards.

Donnelly (2018) wrote about the response of the then minister of the Department of Energy, Minister Jeff Radebe, regarding Government's commitment to the issue of supporting refinery upgrades. The Minister, according to Donnelly, acknowledged the aging nature of current refineries, making a commitment to consulting with the industry and providing policy certainty by the end of 2018. These refineries (as depicted in Figure 5.1), are unable to produce Clean Fuels 2, largely due to the high costs involved and the surplus of liquid petroleum products available in the international market (Oirere, 2017). The volatility of the oil price is also cited as another reason for refineries' (especially the privately owned) battle to commit any infrastructure spend to upgrade their facilities (Wilkinson, 2017). In countries like Egypt, this writer noted how policy changes such as deregulation of fuel pricing and decreasing or phasing out of subsidies, should assist in improving the situation in the oil industry. When it comes to the refurbishment of South Africa's refineries towards meeting CF2 specifications, Donnelly (2014) described Government as an institution that is 'stuck between a rock and a hard place', with Mathews (2018) citing a need for Government to attract substantial foreign investments, especially if the much politically loved 7 billion US Dollar project like Project Mthombo is to be realised.

Figure 5.1: Aging refineries in SA requiring upgrade (Oirere, 2017)

While debates about Clean Fuel 2 are ongoing, the world is continuing to produce and bring into South Africa, the latest Internal Combustion Engine (ICE) powered vehicle models that require higher quality fuels that are equivalent to Clean Fuel 2 specifications. DoE (2011) noted that that developed nations including the EU, Japan and the US have the expertise and equipment to assist developing regions like South Africa modify refineries towards the production of cleaner fuels. The industry's response in this regard has been that, it is busy investigating measures to introduce cleaner fuels in the near future (SAPIA, 2018). One interim option involves the importation of finished petroleum products, hence introducing the question of competition. Pegler (2018) argued that, in many countries, local fuel refineries may find themselves at risk from new standards. If these companies are not technically and financially capacitated to produce cleaner fuels, they risk being thrown out of business by international operators with more modern refining capabilities. At the same time, no government according to this writer, should be expected to implement regulation that puts its own citizens' jobs and local industry at risk. What is discussed above is the obvious role of government as a regulator in terms of the mandatory requirements to ban lead and reduce sulphur content of fuels used in South Africa. This is a 'stick' or 'command and control' approach, the kind of intervention, which some critics, according to Cole and Grossman (1999), equate to 'Soviet-style' regulation and 'socialist central planning'. This means that such approaches are 'endemically inefficient' and 'democratically illegitimate'. Cole and Grossman further argued that some:

> …economists, legal scholars and policy makers argue that economic forms of regulation such as effluent taxes and emissions trading are inevitably more efficient than traditional command-and-control regimes for environmental protection, that command-and control environmental regulations can be (and have been) nominally efficient, producing social benefits in excess of their costs; and at times, they have been more efficient than alternative 'economic' approaches to regulation (Cole and Grossman, 1999: 887-888).

In the midst of ongoing discussions between industry and government, as alluded to in Miller (2019) and Mathews (2018), the oil industry is reported to have made commitments to go ahead with upgrades to meet CF2 specifications. Reuters (2018) reported BP Southern Africa's plans to invest between R3.5 billion and R4 billion in the next five years, to upgrade amongst others, its Durban-based refining plant and producing low sulphur diesel that meets CF2 requirements. While not a focus in this thesis, another driver to BP's move, according to Reuters (2018), relates to a need to comply with the International Maritime Organisation (IMO) Convention for the Prevention of Pollution from Ships (Marpol Convention). Although targeting bunker fuels, this regulation seems to have provided a needed force to encourage investments in BP's upgrade to low sulphur diesel. While Reuters did not disclose BP's source of funding for the upgrade, the move highlights the importance of Government's intervention to encourage industry migration to cleaner fuels.

Besides the CF2 programme, it is noted in SAMSA (2018) that South Africa ratified the Marpol Agreement in 2008.

The debates in the preceding paragraphs highlight the policy role that Government has played so far in the introduction of cleaner fuels. Government intervention, according to the World Bank Public-Private-Partnership Legal Resource Center (2019), can play a major role in driving technological change towards sustainable outcomes. While some industry players have made efforts to facilitate certain upgrades, the regulated nature of South Africa's liquid fuels market, invites more efforts on the part of Government to make available various support programmes/ incentives. Citing international best practices, DoE (2011) had acknowledged a need for South Africa to develop a mechanism to finance the transition to cleaner fuels. This acknowledgement cited differential taxation and pricing mechanisms as international examples, where less polluting fuels are taxed/ priced relatively lower than their more polluting counterparts. This is, however, a demand pull measure which is not without its own limitations. Besides, this measure requires a certain level of commitment from the country's finance ministry (National Treasury). SAPIA (2016) alluded to the agreement reached between DoE and the industry that a cost benefit analysis (funded jointly by the DoE and SAPIA) for cleaner fuels should be undertaken by an independent third party. This analysis according to SAPIA would update the benefits and costs of cleaner fuels, hence equipping Government with enough information to make informed decisions whether or not to compensate the industry for the upgrades.

It is noted in Wilkinson (2017) that South Africa's refineries are at a tipping point, with the introduction of new, cleaner and more efficient technology considered by this writer to be critical for the sustainability of local refineries. While routine maintenance and capital upgrades are complex and expensive, it is also becoming increasingly cheaper to import clean fuels. The three available options for South Africa that SAPIA (2018) indicated, therefore, include upgrading of existing refineries; building of new refineries and/ or continuing to import fuels that meet Clean Fuel 2 specifications. All these options have their own strengths and limitations, which are however not a key focus of discussion in this research. Instead, the next section discusses another transport greening option (fuel economy improvement), which forms part of a suite of transport greening measures available to the South African policy makers.

5.4. POLICY FRAMEWORK RELATING TO FUEL ECONOMY

This section provides a brief discussion of policy frameworks that relate to automobile fuel economy in South Africa. Fuel economy refers to the number of kilometres that a vehicle can be driven using a litre of fuel (e.g. 20km/ litre vs 10km/litre). Assuming that everything is the same, e.g., same vehicle model, equal age, same load, same driving behaviour, etc., the latter vehicle in the example, can be labelled as being less fuel efficient than the former vehicle, because one litre gives a driver fewer kilometres. As explained in Posada (2019), CO_2 emission, on the other hand, describes how much CO_2 (in grams) is emitted per kilometre driven. These two concepts (CO_2 emission and fuel economy) are however closely linked, with Posada (2018) identifying a number of areas in an ICE powered vehicle, that contribute to efficiency loses. These include in summarised form, the engine, the transmission, accessories, idling, body design and weight as well as road driving behaviour. Also, traffic condition as well as the manner a vehicle is maintained and serviced, as indicated in SABS (2006) and Figure 5.2, all play a crucial role in the fuel efficiency performance of a vehicle. In essence, these are areas that a fuel economy policy framework could be targeting.

The National Road Traffic Act (Act 93 of 1996) makes important provisions regarding the design and use of vehicles on public roads. Section 75 (1) specifically gives powers to the Minister of Transport to make regulations on specific matters to achieve the objectives of the Act, and as a result, many regulations have followed. The Act also makes provisions regarding the manufacture of vehicles, operation of such vehicles on public roads as well as conditions with which these may be operated. It regulates the emission of exhaust gas, smoke, fuel, oil, visible vapours, sparks, ash or grit from any vehicle operated on a public road. This seems to have some implications for the fuel economy discussion in this section, especially if it can regulate the manufacture of such vehicles as it implies. It can then be used to bring in the required vehicle technology to achieve fuel economy aspirations (should South Africa set any targets). Nonetheless, the current policy framework that seems most relevant in this fuel economy discussion is the national standard discussed in the following sub-section.

5.4.1. National standardisation and compulsory requirements for fuel economy

Sections 28(1) and (2) of the Standards Act (Act No. 8 of 2008) makes the following provision regarding the incorporation of South African National Standards in laws. The same provision appears in the National Regulator for Compulsory Specifications Act (Act No.5 of 2008):

> A South African National Standard, or any provision thereof, that has been published in terms of this Act in respect of any commodity, product or service which may affect public safety, health, or environmental protection, **may** be incorporated in any law. It can therefore be incorporated by referring to the title and the number; or referring to the title, the number and the year or edition number (Government Gazette, 2008: 20).

This provision seems to be in line with section 22(1) of the previous version of this Act (i.e. Act No. 29 of 1993). According to this section, the Minister (after following prescribed procedures), may declare a specification which has been set and issued as a standard or a provision of such specification, to be a compulsory specification. He/she can also amend or withdraw such a compulsory specification. The relevant standard document developed by the South African Bureau of Standards (2006), in line with these provisions, is SANS

20101: 2006, referenced in the National Regulator of Compulsory Specifications (NRCS) Act, 2008 (Act No. 5 of 2008). The standard was made compulsory through gazetting in 2014 (i.e. Gazette No. 37958 of 5 September 2014). It applies to new passenger vehicles powered by conventional fuels or driven on hybrid power train, stipulating the following requirements with respect to fuel economy:

- Every petrol and diesel powered vehicle shall have applied to the inside of its windscreen a fuel consumption label;
- The label shall be self-adhesive and removable and of a type suitable for application to the windscreen;
- The label shall be placed in the bottom corner of the windscreen;
- The fuel consumption label shall contain the following statements and information.
    - The words "FUEL CONSUMPTION" or "FUEL ECONOMY" as a heading, the vehicle make, model or description.
    - The fuel consumption and carbon dioxide emissions values as determined by SANS 20101: 2006 recorded in litres per 100km and grams per km respectively (Gazette No. 37958 of 5 September 2014).

Figure 5.2 indicates how the fuel economy and CO_2 emission ecolabel could look in a new South African vehicle sold at a dealership as required in in terms of Government Gazette (Gazette No. 37958 of 5 September 2014).

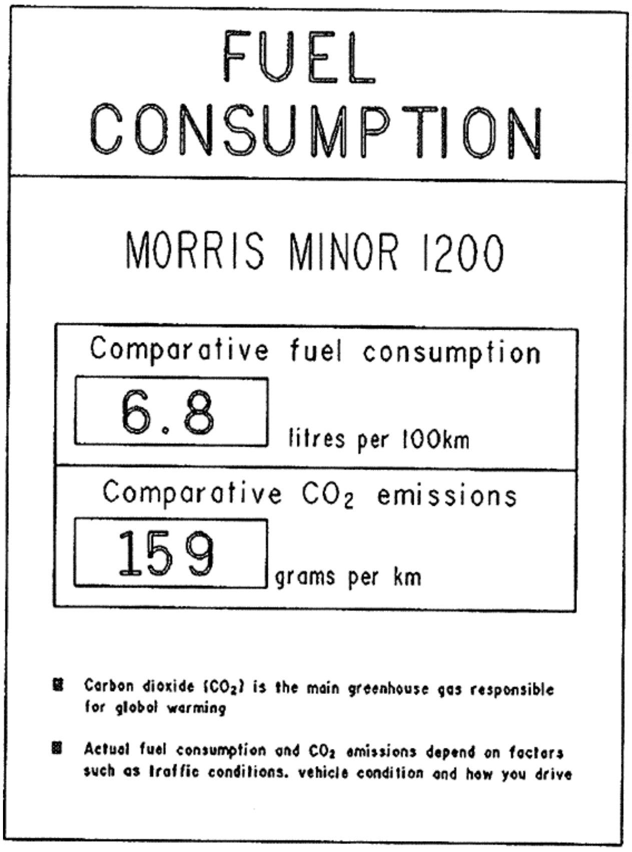

Figure 5.2: Fuel consumption label for petrol and diesel vehicles (SABS, 2006)

Government therefore specified mandatory labelling for new passenger cars, indicating fuel economy in litres per hundred kilometres (l/100km) and carbon dioxide (CO_2) emissions in grams per hundred kilometres (g/km). This measure enables consumers to make model-to-model comparisons with regard to new vehicles' fuel consumption and CO_2 emissions. In principle, this should raise awareness as it allows consumers to make conscious decisions regarding the environmental and the cost/ economic impact of the vehicles they intend to buy. The standard also requires vehicle emission testing for new vehicles, which is facilitated by the National Regulator of Compulsory Specifications (NRCS). It is from this process that dealers derive emission and vehicle economy data (NAAMSA, 2008).

It must be noted that the effectiveness of a fuel economy standard depends on many factors including the provision of incentives or sanctions to encourage compliance. As stipulated in sections 24 and 23, of the Standards Act (Act No. 29 of 1993), non-compliance with a compulsory specification has sanctions associated with it. The sanctions, as provided for in Section 15 of the National Regulator for Compulsory Specifications Act (Act No.05 of 2008) are enforceable by the Chief Executive Officer and by the Board of Directors of the NRCS. They include the following:

- the confiscation and destruction of a non-compliant commodity,
- prohibition from distribution for use by the public,
- returning of such commodities to the country of origin (Government Gazette, No.31216 of 4 July 2008).

While these standards were developed in South Africa, for the vehicles sold in the local market, there are views which seem to suggest the role of global influence on this country's decision to develop the standards. The following sub-section briefly discusses such views.

5.4.2. International drivers behind South Africa's fuel-economy standards

Vosper and Mercure (2016) made a statement which seems to link both the Clean Fuels programme discussed in Section 5.3 and the fuel economy standards discussed in this section, to global influences, specifically the influence of the European Union. These writers suggested that South Africa has followed Europe. The fuel economy labelling used in South Africa was, according to NAAMSA (2008), based on the system used in the European Union. A closer look at this standard confirmed that it is indeed based on European ECE R101:2005 and ECE amendment 1, and was adopted following permission of the United Nations Economic Commission for Europe (Gazette No. 37958 of 5, September 2014).

It is argued in this thesis that there is indeed an international drive towards encouraging global countries, including the periphery and semi-periphery countries like South Africa, to adopt fuel economy standards. The study conducted by Posada (2018) of the International Council on Clean Transportation (ICCT), reveals much about this initiative at an international level. It is a Global Fuel Economy Initiative (GFEI) driven in partnership between the following institutions:

- International Energy Agency (IEA),
- United Nations Environment Programme (UNEP),
- International Transport Forum of the OECD (ITF),

- International Council on Clean Transportation (ICCT),
- Institute for Transportation Studies at UC Davis, and FIA Foundation (Posada, 2018).

Based on the shared evaluation for in-country fuel economy and CO_2 policy support development, the fuel economy initiative works towards securing real improvements in vehicle fuel economy, globally. The findings of Posada's study have relevance to South Africa as they showed that South Africa's vehicles are extremely fuel inefficient compared to vehicles used in the European Union. Posada's comparison of SA vehicles with those in the EU is based on SANS20101, which is also based on the EU standard.

The discussion in this sub-section is therefore in line with the arguments presented in globalisation theories explained in Robinson (2007). Also Gerau (2012) described Europe as a directional leader, for having externalised its environmental protectionist rules and values to developing countries. The South African case and its linkages to the arguments presented above, demonstrates the applicability of globalisation theories introduced in Chapter Three. While this country has adopted an international standard, there are still many limitations/ gaps in the standard, which as discussed in the next sub-section, require some kind of intervention on the part of Government.

5.4.3. Limitations of the South African fuel economy standard

The first and major limitation of the South African Fuel Economy standard relates to the fact that it applies to new vehicle testing, and only serves as an eco-label. As such, it targets the demand-side as it sets no real fuel economy targets for new passenger vehicles, compared to the standards in other core and semi-periphery countries (as discussed in Chapter Seven). The second limitation of this standard relates to its exclusion of commercial vehicles. Commercial vehicles, according to NAAMSA (2008), were not included as part of the requirement, since the varying weight conditions under which these vehicles operate, made the standardised unladen test less meaningful. NAAMSA had, however, mentioned that fuel economy figures for commercial vehicles, could be obtained direct from commercial vehicle manufacturers.

The third limitation of this ecolabel relates to its limited focus on new vehicles. This means that buyers of second hand/ used vehicles are deprived of a chance to take advantage of the benefits of this standard. They cannot identify the fuel economy performance of second hand vehicles they intend buying, since vehicle sellers are not obliged to disclose this. Crouth (2019) labelled this country as a predominantly used car market. The second hand car sales were reported by one of the country's online traders (Autotrader), as having reached a value of R10.2 billion in January 2020 (Businesstech, 2020). This issue also appeared prominently in an interview session with a policy maker in a provincial department who stated that she is keeping an old gas vehicle that consumes a large amount of fuel.

This vehicle does not indicate fuel economy figures. The point this respondent was making is that awareness raising is limited to the type of vehicles available on the market. When consumers are equipped with sufficient knowledge on various aspects of a car, including fuel economy performance, better choices can be made. This sentiment was also made in Surkont (2016) who argued that, the used car industry dealers are often viewed as predatory, lack transparency and often buyers and sellers do not have access to the same information as 'dealers'.

The Clean Fuel I and the fuel economy standards were both developed in 2006. This pattern suggests that green thinking in vehicular fuel economy and fuel quality improvement were taking place at the same time. With the limitations discussed on the fuel economy standard, the question remains: will the South African Government ever improve these standards, or will it simply migrate to the next policy position, promoting a switch to alternative greener technologies in transport? The following section discusses the South African policy landscape around the promotion of alternative vehicle technologies.

5.5. POLICY PROVISIONS RELATING TO TECHNOLOGY SWITCH

The phrase "technology switch" in this section is used to mean a shift away from use of vehicles traditionally powered by fossil-derived petrol and diesel, to vehicles powered by alternative and greener types of energy. These energy types include renewable electricity produced from solar, wind, hydro or any other renewable source; compressed biogas (CBG); liquid biofuels and hydrogen. Energy sources that also qualify include compressed natural and liquefied petroleum gases (CNG and LPG). As noted in Brinson (2020), these are considered transitional fuels, as they bridge the gap between the use of fossil and renewable energy sources. The section also incorporates vehicles powered by dual fuel systems such as plug-in hybrids (PHEVs), hybrids (HEVs) and those powered by both conventional petrol/diesel and CNG/ LPG or hydrogen.

Most policy, regulatory and legislative provisions presented and discussed in this section relate to the fiscal and monetary policy levers available to Government and the way in which these levers support or deter the switch from traditional to green transport technologies. One such legislative lever is the Customs and Excise Act (Act No. 91 of 1964), which provides fiscal tools such as tariffs, subsidies, exemptions, duties, tax rebates or levies on goods and services, which have a certain impact on the consumers and producers of these goods and services. Other legislative frameworks that also regulate demand for goods and services are the finance and procurement legislations which govern Government financial management and procurement at national, provincial and local levels. The following sub-section provides an overview of policy, regulatory and legislative measures that hinder the adoption of a technology switch in South Africa.

5.5.1. Policy measures hindering a technology switch

A variety of measures that hinder a green transport technology switch from conventional fossil fuel internal combustion engine (ICE) type of system to new alternative transportation systems were identified during this research, and are discussed in the following sub-sections. These measures highlight shortcomings of Government in a manner that supports arguments against the government interventionist approach.

5.5.1.1. High import duties on complete green cars

As recorded in Schedule 4/Part 1 of the Customs and Excise Tariff Book of the South African Revenue Services (SARS, 2018), tariffs on imported green vehicles are still high compared to the conventional petrol/ diesel versions of similar tariff headings. Products that are still heavily protected include the fully electric vehicles, plugged-in and hybrid electric vehicles for passenger commuting, goods haulage and public transportation. The same applies with bodies of these vehicles. As noted in SARS (2018), these are well protected from all countries at the maximum import duty of 25%. This is high compared to their ICE counterparts that enjoy zero rate (under 1000 cc vehicles) and a maximum of up to 18% duties in the case of other vehicle categories. The exception is if green vehicles are imported from the Southern African Community Development (SADC) region, where they attract zero duties. While this country has a globally recognised automotive manufacturing sector, the electric vehicle segment is still nascent. All battery electric, plugged-in hybrids and/or associated components are currently being imported. Local consumers hence incur the full costs, as the added costs of import duties get passed onto them. This is likely to limit the uptake of electric vehicles in the country, an argument that is often backed up by the small number of units that have been sold so far in the local market as alluded to in Chapter One, and as per figures from Mahomedy (2019) and Venter (2017).

Reasons often used by governments to justify the imposition of tariffs include national defence purposes, supporting domestic employment, combating aggressive trade policies and environmental reasons (Investopedia, 2015). But what really drove the South African Government to impose these tariffs has reasons that relate to efforts aimed at raising revenue and to protecting the local automotive industry. As instruments of industrial policy, tariffs according to the International Trade Administration Commission of South Africa (ITAC, not dated) have implications for capital accumulation, technology, productivity growth and employment. As a general guideline, ITAC (not dated) reduces tariffs to lower input costs into labour-intensive employment creating downstream industries. To create jobs and to ensure long-term sustainability and global competitiveness of the industry, tariffs on downstream industries, are raised judiciously on a case-by case approach. This seems to imply that the importation of automotive components, with the aim of assembling the vehicles in South Africa, stands a chance to benefit from lower tariffs as opposed to the importation of fully assembled automobiles. If this is the case, then it is argued in this research that the opportunity in the automotive industry rests with technology switch, which should involve the establishment of new green vehicle assembly lines in the country. This will involve the importation/local sourcing of green automotive components and assembling of EVs in the country. This call requires a certain level of commitment on the part of headquarters of global automobile OEMs, with a presence in South Africa.

Whether high tariffs on imported green automobiles are capable of contributing to job preservation in the conventional automotive sector, is debatable. In his presentation at the Smart Mobility Africa Conference, Cloete (2019) noted that the EV transition might generate large-scale employment that facilitates 4th industrial revolution ICT software programmers, coupled with electricians/installers, vehicle/battery repairs and vehicle factory workers. This is indeed a switch to new types of jobs in the automotive industry, as opposed to job losses. This includes the auto industry shift to the subscription model for cars instead of buying or leasing – especially among the luxury car makers whose customers can more easily afford the premium cost of this approach (Cloete, 2019). From an environmental point of view, the ‘removal of tariffs’ argument, on the other hand, seems to hold. Increased addition of EVs to the country’s road fleet holds potential for South Africa to reduce its emissions of greenhouse gases (GHGs) (DoT, 2018).

The justification for high tariffs, however, does not hold in cases where the industry is non-existent. In principle, a higher tariff automatically discourages people from buying a product, hence forcing the country to forgo the potential benefits of associated pollution abatement in the case of green vehicles. This is the case with electric vehicles that are currently charged the maximum duty of 25% and Ad Valorem duty of 18%, making the total tax on these environmentally friendly machines soar. The question therefore would be: what is being protected from imposing higher tariffs on such green products? The impact of a higher tariff, according to Radcliffe (2017), can be explained in simple demand and supply curves as depicted in Figure 5.3.

On assuming that price changes from non-tariff P* to P', domestic producers/ suppliers will respond by increasing the quantity of goods they supply to the market, hence causing movement along the supply curve from Q to Qd. Because the goods are now more expensive, buyers will respond by reducing the quantity of goods demanded, hence causing movement along the demand curve from Qo to Qw. This leads to the contraction in the size of imported goods and improvements in local production. This could explain the small number/ volume of BEV, PHEV and HEV units sold in South Africa since the EV market opened its gates in the last couple of years. Since the tariff has a tendency to raise prices of imported goods, Radcliffe (2017) noted that this incentivises domestic suppliers/producers not to reduce their prices, since the competition will have been reduced.

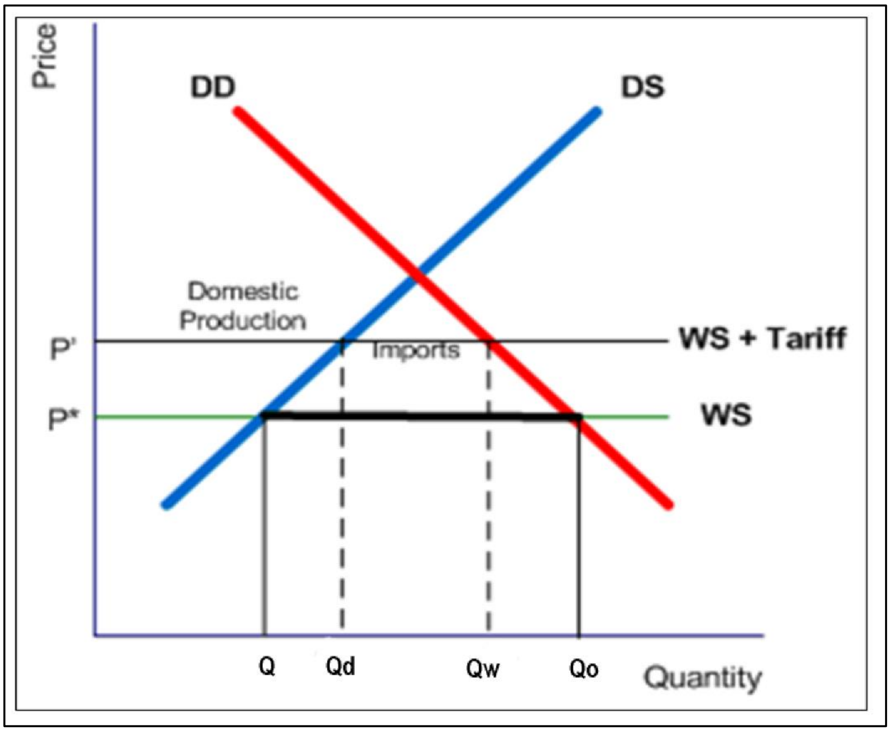

Figure 5.3: Product price under the effect of a tariff (source: adapted from Radcliffe, 2017)

Radcliffe's analysis would be more applicable if the goods referred to were analogous, but in the South African case the comparison is not between apples and apples. It is rather between greener vehicles and traditional ICE fossil-based vehicles. So the higher tariff boosts the manufacturing and sale of traditional vehicles as opposed to boosting the sale of energy efficient vehicles such as BEVs and PHEVs. As noted in Mahomedy (2019), South Africa currently imports all green vehicles, as new production lines have not been set up. Radcliffe (2017) therefore emphasised the role of trade liberalisation in growing the quantity of consumer goods available to local buyers. Global trade also impacts positively on prices due to the presence of many players in the market.

In South Africa, there are thus diverse national imperatives such as industrial development, upliftment of people's quality of life and environmental protection. The current approach in transport industry greening is also driven by various groups, some of which share competing and often different interests regarding the type of transport greening route the country should take. Various transport greening technologies include vehicles powered by cleaner fuels, electricity, hybrid systems, biofuels, biogas, petroleum gas and hydrogen fuel cells. Tariffs are a form of tax, and tax according to Mohr et al. (2015) serves as one of government revenue collection sources. Any loss in such revenue therefore needs to be offset by an increase in other revenue collection streams. Prior to making any recommendations with respect to certain duties/tariffs imposed on imported products, it is important to take all these issues into consideration.

What becomes questionable is the protection of sectors that do not have a local presence yet, e.g. manufacture of green automobiles such as electric vehicles. The local vehicle industry protection argument in such cases therefore does not hold, as with the collection of revenue from the sale of imported electric vehicles argument. To date, very few electric vehicle units have been sold in South Africa as indicated in Chapter One. These vehicles are still too expensive and are hence not yet affordable to the ordinary person. With such small numbers to date, it looks like the South African Revenue Service is not generating much revenue from the import duties and the ad valorem tax currently levied on these machines. By reducing/ removing these taxes, the country will not incur significant losses, provided that the reduction/ removal does not remain indefinitely. As a demand pull measure adopted successfully in countries like China, Norway and Brazil, government fiscal measures such as subsidies, rebates, etc., cannot afford to continue subsidising the adoption of greener automobiles indefinitely. At some stage, when the industry is fully operational and able to compete at a global scale, these support mechanisms need to be reconsidered or abolished. Shift to supply targeting tools, such as China's NEV and California's ZEV schemes discussed in Ou et al. (2019) and Hardman et al. (2018) are living examples of long-term limitation of demand-targeting tools. In the short term, however, these tools have significantly encouraged the uptake of green automotive technologies.

The current import tariffs in South Africa seem to protect the traditional automotive industry, not the local EV industry, since the latter is non-existent. To boost the market uptake for green automobiles, including EVs, some form of interim support is therefore required, including the reduction in import tariffs. The execution of green vehicle tariffs under the 'infant industry' argument then seems justifiable only when South Africa has commenced with the production of green vehicles, but is not yet ready to compete with advanced players in the international markets.

5.5.1.2. Ad valorem customs and excise duty on green cars

The ad valorem duty is imposed on several items deemed to be luxury or not essential. This applies to any goods which are manufactured in South Africa or to imported goods of the same class or kind (SARS, 2018). This includes automobiles such as Battery Electric Vehicles (BEVs) and Plug in Hybrid Electric Vehicles (PHEVs) that fall within the categories 'passenger vehicle' and 'light commercial vehicle'. DoT (2018) noted that this duty is levied based on the price of such vehicles. As such, BEVs would be charged around 18%, which is additional to the 25% import tariff as discussed in the previous sub-section as well as the 15% Value Added Tax (VAT). According to Schedule1/ Part 2B of the Customs and Excise Act, the rate of excise duty on vehicles imported into South Africa is calculated as follows:

> …(0,00003 x B) - 0,75% with a maximum of 25%. "B" means the value for the ad valorem excise duty on imported goods as prescribed in section 65(8)(a) of the Act…

> Notwithstanding the provisions of subsections (1) and (4), the value for the purposes of the duty specified in Section B of Part 2 of Schedule 1 shall, in respect of imported goods (other than goods entered in terms of item 412.18 of Schedule 4), be the transaction value thereof plus 15 per cent of such value, plus any non-rebated customs duty payable in terms of Part 1 and Section A of Part 2 of Schedule 1 on such goods, but excluding the duty specified in the said Section B of Part 2 of Schedule 1 on such goods (SARS, 2018: 1).

The use of this formula automatically renders these products 'luxury products', hence elevating their price compared to similar products in the same category (e.g. passenger vehicles). With the current classification of electric vehicles as luxury goods in the country's taxation system, this puts a strain on their price, hence limiting their accelerated adoption (Chapman, 2019). This renders many potential buyers unable to afford these vehicles due to the high import tax, which Chapman calculated as 43%, when taking into consideration both the import tariff of 25% and the ad valorem excise duty of 18%. In October 2019, Chapman (2019) noted that the price of a BEV in South Africa was around R650 000. More affordable EV models are however expected to enter the country should existing barriers to entry, such as the ad valorem excise duty discussed in this sub-section, be relaxed.

Besides the existence of protectionist measures such as the import tariff and the ad valorem excise duty discussed above, it is argued in this thesis that there are other barriers to technology switch in South Africa. They include, as discussed in the next sub-section, the way certain finance provisions are interpreted and implemented during procurement processes in various spheres of Government.

5.5.1.3. Rigid application/ or misinterpretation of finance and procurement legislation

As shown in Chapter One not many green vehicles have been procured by the Government of South Africa. Only a few examples in the form of electric vehicles form part of the Government fleet. There are many questions around Government procurement positions such as what stops Government from owning a green fleet? Service providers such as Avis, Budget and many others, do business with the state. This includes public transport bus operators, who, as noted in National Treasury (2016), receive government subsidies. As such, what stops Government from stipulating conditions in contracts, requiring such service providers and beneficiaries to keep an agreed number of green vehicles in the fleet used by government departments? The answer probably relates to the fact that green procurement is not yet well-established across government departments. The exception is a few metro municipalities such as the Cities of Cape Town, eThekwini, Ekurhuleni, Nelson Mandela Bay and Tshwane which, according to Sustainable Energy Africa (2012), have to a certain extent, already developed green procurement policies. At national level, and within the context of transport sector, this could change given that the green transport strategy by DoT (2018) now makes provisions for Government to develop policy guidelines for green procurement of transport goods and services. When this policy guideline is finalised and green procurement finally takes off, it will also be required to comply with requirements of the Public Finance Management Act (Act No. 1 of 1999) or PFMA, which in turn applies to all organs of state listed in the relevant schedules of the Act. On the other hand, municipalities are governed by a different set of finance rules, provided for in the Municipal Systems Act (Act No. 32 of 2000) as published in the Government Gazette (Gazette No.21776 of 2000).

Linked to the Government finance rules is Section 16A6.1 of Treasury Regulations of 2005, regarding the procurement of goods and services by organs of state. This section stipulates a requirement that any procurement by these organs of state should strictly comply with minimum values set by National Treasury. As of December 2011 the Preferential Procurement Policy Framework Act (PPPFAct, Act No.5 of 2000) and related regulations, including the Preferential Procurement Framework Regulations of 2001 and Treasury Regulations of 2005, applied to all institutions provided in schedules 2 and 3 of the PFMA. These frameworks provide procedures for Government procurement of goods and services. It is worth noting that the PPPFAct has its roots in section 217 of the country's Constitution, which in turn makes provisions for the organs of state to adopt a fair, equitable, transparent, competitive and cost-effective bidding procurement process. This may include procurement of transport related goods and services.

State procurement is guided by different sets of principles, with one such principle being the 80/20 principle, which applies in contracts that have a Rand value equal to or below a prescribed amount. This means that 80 points are allocated for price competitiveness and 20 points are assigned for economic development, which includes compliance with Broad Based Black Economic Empowerment (BBBEE) as defined in the BBBEE Act (Act No. 53 of 2003). The framework also provides for a 90/10-point system, which applies in situations where contracts have a Rand value that is above a prescribed amount. The Act has provisions for use of a specific formula in determining the preferred bidder/s of specific goods and services. The formula, as stated in the PPPFAct Regulations Implementation Guideline, can be described as follows:

> $Ps = 80\,[1-(Pt-Pmin/Pmin)]$; Ps = points scored for comparative price of tender or offer under consideration; Pt = Comparative price of tender or offer under consideration and $Pmin$ = Comparative price of lowest acceptable tender or offer (National Treasury, 2011: 16)

The implications of this formula are that the bidder with the lowest price gets the highest scores on price as depicted in the following example that provides three bidding scenarios, where an 80/20-point system is used. Here, even the highest BEE score fails to help the bidder with the highest price to get a lower score. Added together, these price scores and the scores on economic development determine who the final bidder is. The higher the final score, the more preferred the bidder will be, unless the accounting officer decides otherwise in terms of Section 7 of the PPPFA Regulations (National Treasury, 2011). The price referred to, however, is not the true reflection of the actual price for goods and services rendered, as it does not factor in the negative externalities associated with the provision of the said goods and services. As indicated in Mahomedy (2019), South Africa currently imports all green vehicles such as BEVs and PHEVs. By the time these products are handed over to a South African consumer, they will already have incurred a higher premium compared to their ICE counterparts. This could be due to many factors including the additional import costs imposed on them such as the 25% tariff and ad valorem excise duty of 18% as discussed in the preceding sub-sections. The author therefore argues that a decision maker/ procurement official in a public institution is faced with a dilemma.

Table 5.3: Example of bidding scoring (by author based on the PPPFAct, No.5 of 2000 and BBBEE Act No. 53 of 2003)

	Bidder 1	Bidder 2	Bidder 3
Bidding price	R900 000	R800 000	R650 000
Bidding score	49	62	80
Final scores with BEE added assuming the indicated BEE scores	69 (at 20 BEE)	72 (at 10 BEE)	81 (at 1 BEE)

It is a dilemma brought about by the strict procurement requirements that tend to favour lesser priced contracts; on the other hand, green automobiles have proved to be more expensive when compared with their ICE powered counterparts. This dilemma therefore brings in the question of the decision maker’s commitment to sustainable development and greening principles. The decisions and the manner in which such decisions are facilitated in South Africa will depend on the worldviews held by those involved in decision making about what to procure and what not to procure. Much was discussed in Chapters Two and Three on existing views around the concepts of ‘green economy’ and ‘sustainable development’. These include world views presented in WCED (1987), Wallis and Valentinov (2017), Willard, 2010 and Lotz-Sisitka et al. (2017), among others. It is argued in this research that in South Africa, there are decision makers that hold sustainable development world-views. This is demonstrated later in Chapter Six.

To help members of the panel respond to a question at the 2018 Sustainability Week Conference in Pretoria, South Africa, a senior official from one of the country’s largest metropolitan cities, was quoted as saying that:

> When you issue out a tender to bid, your specifications will be for a particular mode/ type of a bus, allowing you to compare apples with apples on the vehicles to be procured…. If you want electric buses, bidders will have to bid for electric buses only. None will bid for gas buses while the other bids for dual fuel buses (City of Tshwane Official, 2018).

One can go for a higher priced good if by so doing, certain imperatives of national priority, will be achieved, e.g. reduction in the emission of GHGs and tail pipe gases that cause health problems. This can be done through Section 7 of the PPPFAct Regulations, which makes provisions for the awarding of a contract to a bidder that scored fewer points. Section 2(1) (f) of the said regulations clearly outlines conditions for the allocation of bids, as follows:

- the bidder is a person or belongs to a category of persons historically disadvantaged by unfair discrimination on the basis of race, gender or disability;
- awarding the bid will implement the programmes of the Reconstruction and Development Programme as published in Government Gazette No. 16085 dated 23 November 1994;
- any specific goal for which a point may be awarded, must be clearly specified in the invitation to submit a tender (Gazette No. 34350 of 2011:7).

In concluding this sub-section, the key point is that a case for procuring a green fleet can be made, provided that the procuring official is able to justify it by referring to, and abiding by, prescripts and procedures stipulated in the procurement regulatory framework. In other words, on the part of those involved in procurement, this requires commitment by thinking 'outside the box' and avoiding falsely interpreting and rigidly applying finance and procurement legislative provisions.

5.5.1.4. Heavy subsidisation of conventional automobiles and lack of market for green automobiles

South Africa's automotive industry has been supported for many years since this country evolved into a democratic state. The two main support schemes are the Motor Industry Development Programme (MIDP) and the Automotive Production Development Programme (APDP). As shown in Table 5.4, while the former scheme expired in 2012, the latter was scheduled to expire in 2020 (Department of Trade and Industry, 2017). Both schemes had four pillars as depicted in the table. These schemes, especially the APDP, have been key in supporting the automotive industry to manufacture the automobiles for both the export and the domestic markets (Barnes et al., 2018). They provide support measures, which were founded on the principles contained in the country's National Industrial Policy Framework (NIPF) which placed emphasis on the need for the country's economy to undergo fundamental restructuring, facilitating employment opportunities, among others (Department of Trade and Industry, 2008).

As depicted in Table 5.4, the automotive incentive schemes provide support to the general automotive industry. While this does not exclude green automobiles, the schemes do not contain provisions that specifically and explicitly promote local manufacturing of 'green' vehicles. As such, the schemes seem to have encouraged 'business as usual' behaviour on the part of traditional OEMs present in this country, and hence there is no drive to upgrade existing ICE-based production lines and/ or add new production lines to accommodate local manufacturing of green/ energy efficient vehicles. Another criticism relates to the threshold set under the Volume Assembly Allowance. In a study by the Department of Trade and Industry (2016), an argument was made that the automotive production threshold of 50 000 units, as shown in Table 5.4, is too high for a nascent industry such as green vehicles. As such, these support schemes are deemed to be more suitable for the well-established ICE-based automotive assemblers / manufacturers in South Africa, who are able to meet the set threshold.

Table 5.4: The MIDP compared with APDP (Extracted from the Department of Trade and Industry, 2017)

	MIDP (1995 – 2012)	APDP (2013 – 2020)
Tariffs	The level of protection offered by **tariffs reduced consistently from 65% and 49% for CBUs and CKDs respectively in 1995, to 25% and 20% in 2012**	The level of protection offered by **tariffs will remain constant at 25% and 20% for CBUs and CKDs respectively from 2013 to 2020**
Local OEMs Vehicle Allowance	**DFA (Duty Free Allowance):** 27% of the local assembled vehicle's wholesale price is rebated against the duty payable on imported components that are used in the production of vehicles for the domestic market	**VAA (Volume Assembly Allowance):** 20-18% of local assembled vehicle's wholesale price is rebated against the duty payable on imported components that are used in the production of vehicles, irrespective of where the production is sold, as long as annual units per plant exceed 50,000
Industry incentives	**Export linked duty credits earned:** Benefits calculated on local material used	**Market neutral PI (Production Incentive) in place:** Benefits calculated on local production value Vulnerable Industries higher benefits
Investment assistance	**PAA (Productive Asset Allowance):** • Only benefits OEM and 1st tier suppliers whose investment is linked to a local OEM • 20% benefit, payable over 5 years (4% per year)	**AIS (Automotive Investment Scheme):** • Benefits OEM and auto component suppliers as long as investment is auto focused • 20-30% benefit, payable over 3 years (6.67% per year)

As noted in Ou et al. (2019), the Chinese EV industry did not grow out of traditional OEMs alone. Instead, the expansion of the EV market, incentivised by Government, enabled young, privately owned automakers to compete with established automakers. Another example is USA Tesla, which has grown enormously, even though this company is a new entrant in the automotive industry, when compared with well-established traditional automotive OEMs such as Ford and Chevrolet.

The question then is why did South African automotive OEMs not take the opportunity and use the Government automotive incentive programme to add green cars to their production lines? This could be explained by examining global value chains regarding decisions on who should manufacture what and when. In Chapter Three, the OECD (2016) report revealed that OEMs control what can be manufactured at their branches located in other parts of the world. It was revealed that in smaller production locations like South Africa, only less complex components or no components at all are produced locally. In these countries, the choice is to either bring in vehicles in ‘complete-knocked-down' (CKD) model of assembly, or bring these vehicles in a completely-built-up (CBU) state. The latter model attracts more import tariffs and ad valorem duties as is currently the case in South Africa, with respect to green cars such as EVs and PHEVs, which as noted in Mahomedy (2019) are all imported in CBU format. But what stops South African OEMs from bringing in these machines in CKD format and still benefitting from the automotive incentive schemes? In an interview with a representative of the National Association of Automobile Manufacturers of South Africa (NAAMSA), the following views were expressed regarding market size for green automobiles in the country:

> At present, electric vehicle sales in this country still represent only a fraction of total sales, something similar to most other markets and the situation is likely to remain at low off-take levels up to 2020. With the “Joule” you probably know the story of that initiative – in SA everything is possible, but it must make business sense. The automobile industry is export oriented. With 50 000 units at the time as a requirement for Government support, they were too early with the Joule (N.L, 2018).

Why bring production lines into South Africa, when the market does not yet exist? Indeed this country has not yet set tangible targets for green vehicles, compared to the targets set in parent countries of OEMs present in South Africa. The USA National Academy of Engineering (2015) noted that many factors affect decisions on the best location for a new production plant. These include proximity to raw materials; cost, availability, and reliability of energy; access to skilled workers; labour costs; government regulations and policies and ability to innovate, amongst others. This institution singled out proximity to markets as one of the key factors. The same sentiment was raised by Wright (2018) in an article posted at engineering.com. For heavier products such as appliances and automobiles, the advantage of locating production close to market has many benefits including lower transportation costs. Another key factor that both Wright and the USA National Academy of Engineering highlighted is existence of financial incentives. While financial incentives are important, Wright (2018) warned that the longer term implications of relying on this tool as a final determining factor to locate a plant in a particular area, should not be forgotten. This incentive could become a financial burden, adding shipping costs and lead times if the location is furthest from the market, hence negatively affecting long term sustainability of the plant.

On listening to the discussion by panellists at the Electric Vehicle Industry Conference (EVIA, 2018) in South Africa, various challenges were cited as major hindrances to EV deployment in the country. Panellists comprised representatives of OEMs present in South Africa, including BMW, Nissan and Toyota. While some OEMs were positive that the lack of EV deployment problem could be resolved, others made it very clear that they were here to sell electric vehicles, not to manufacture them locally. As a result, their call for government intervention to remove barriers to trade, is purely to help stimulate the growth and uptake of EVs in South Africa (Creamer, 2018). By removing trade barriers, these OEMS hope that green automobiles will become affordable to a wider customer audience. BMW South Africa, with the support of Nissan South Africa, were quoted by Creamer (2018) as having submitted an official request for Government to remove import tariffs on BEVs for three years.

In addition to the discussion on Government versus industry preferred approaches, there is also evidence of heavy and cross subsidisation of the public, rail and road transport sectors as presented by National Treasury (2016) in Budget Vote 35. This is illustrated in Figure 5.4, where public transport, rail transport and road transport have received relatively large amounts of subsidies in the financial year 2016/2017. The provision of measures to support public transportation is not necessarily a bad idea, especially in the context of modal shift presented later in this chapter with this mode being classified as green in the green transportation pyramid depicted by Urban Hub (2020) in Chapter Two. The problem with subsidisation relates to the lack of specific provisions, requiring participating bus operators to start transitioning to greener operations, including diversification of fleet to include greener technologies. Such requirements are not specified in contract documents with public transport companies receiving state subsidies, hence leaving much to be done under the DoT (2018) Green Transport Strategy, which makes a provision for South Africa to develop green procurement guidelines.

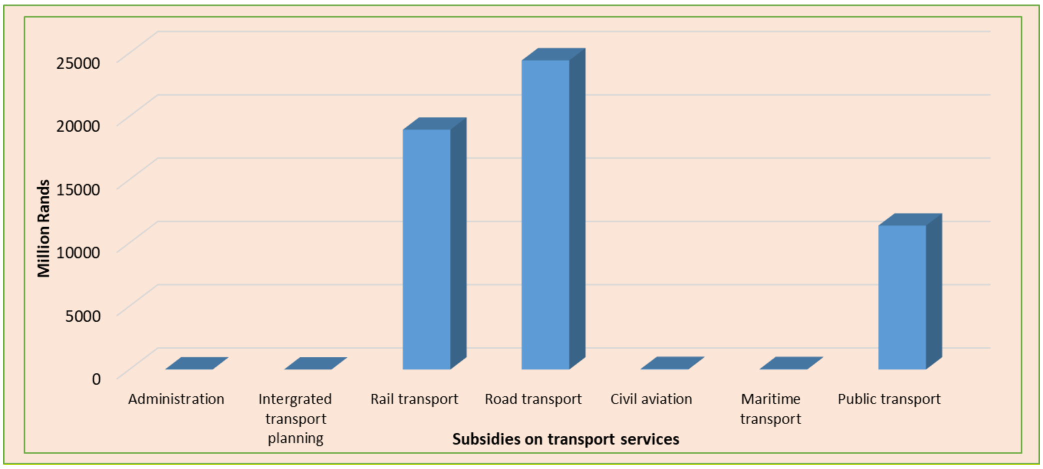

Figure 5.4: 2016/17 Budget Summary on transport sector subsidies (by author from National Treasury Budget Vote 35, 2016)

This discussion also applies to all other service providers to whom Government outsources transport services, including Avis, Budget, Phakisa World and others. These companies do business with the state, hence giving the state some kind of leverage to challenge their ‘business as usual’ approaches, with the aim of encouraging transition to greener alternatives. This discussion thus links well with the previous section, which argued against rigid application of finance and procurement legislative provisions by officials in Government. Specific provisions within various finance and procurement legislative frameworks, can be used to effect the desired changes. This could include the use of sections 7 and 9 of the PPPFAct (Act No. 5 of 2000) and associated regulations as gazetted in Government Gazette (Gazette No. 34350 of 2011). It is argued in this thesis that the development of Green Procurement Guidelines as provided for in the DoT (2018) Green Transport Strategy, provide the first step in the right direction in this regard.

What is clear in these debates is that Government seems to believe that the existing incentive schemes can be used to facilitate OEM investments in greener automobiles. The focus seems to be more on attempting to stimulate the supply side. In the absence of firm OEM commitment to produce these vehicles domestically, Government believes that removal of trade barriers could limit the space for future industrial policy interventions (Creamer, 2018). On the other hand, the industry shows no signs of willingness to invest in an environment where they still deem the market for these machines, to be insufficient. So, the industry seems to be pushing to stimulate the demand, as opposed to the Government interest in stimulating the supply side. Even the recently developed South African Automotive Master Plan – SAAM 2035 as presented in Barnes, Black, Comrie and Hartogh (2018), has its limitations when it comes to transport greening. While it alludes to the opportunities presented by the transition to green automobiles, it continues to propose tightening of trade barriers, on, for example, under 1000cc vehicles. A detailed discussion of this scheme is provided in sub-section 5.5.2.7.

It is therefore concluded that the two issues that hinder transition are the comfort zones created by continued fiscal support of the status quo as well as insufficient market for greener automobiles. Insufficient market is brought about by many factors including the high costs associated with the procurement of these transport goods in relation to their traditional counterparts (i.e. fossil fuel- based ICE automobiles). Besides these issues, other supply push constraints to technology switch include requirements for homologation, as discussed in the next sub-section.

5.5.1.5. Requirements for vehicle homologation

In line with international best practices, new vehicle models, built up vehicles and modifications of vehicles in South Africa, should be homologated through a process described in the national standard SANS 10267 (NRCS, 2020). This requirement is further stipulated in the National Regulator for Compulsory Specifications Act (Act No. 5 of 2008), which was promulgated in the Government Gazette (No. 31216 of 04 July 2008). This formed part of a process that aimed at aligning South Africa with the world’s best regulatory practices and to meet the requirements of the World Trade Organisation (WTO) agreement on Technical Barriers to Trade. It is based on the United Nations (UN ECE) Regulations (Van Tonder, 2019). Through this Act, several regulations were developed to regulate the process, making provisions for compulsory specifications on the homologation of various categories of vehicles. In chronological order, these regulatory frameworks are listed below:

- ❒ In 2010 – specifications on category O (trailers) vehicles as described in Government Gazettes (No. 32916 of 05 February 2010),
- ❒ In 2011– specifications were also made for vehicles of category L (motor circles) of different sizes as described in the Government Gazette (No. 34308.of 27 May 2011),
- ❒ In 2014 – specifications were also set for vehicles of category N1 (goods vehicles with a mass of 1-3.5 tons) and vehicles of category M1 (passenger cars with seats not exceeding 8 people) as described in Government Gazette (No. No. 37958 of 04 September 2014),
- ❒ In 2015 – specifications for categories N2 and N3 (goods vehicles with mass between 3.5-12 tons and 12 tons and above) and categories M2 and M3 (passenger vehicles/ minibus and buses), as described in Government Gazette (No. 39220 of 18 September 2015) (Department of Trade and Industry, 2010, 2011; 2014 and 2015).

In order to prove the conformity of such vehicles with these specifications, the NRCS is the inspectorate responsible for ensuring compliance, by subjecting vehicles to the homologation process (Department of Trade and Industry, 2013). What is common to all these specifications is that they cover all vehicle types irrespective of design, origin and energy used, hence including electric and gas powered vehicles. Also, the specifications explain conditions that trigger a need for homologation of vehicles, and situations where homologation is not required. Homologation is required a vehicle is a new model not previously registered or licensed in the Republic of South Africa (NRCS, 2020). It is also required where a vehicle is assembled from a combination of newly designed bodies and older parts from other vehicles. Homologated vehicles have to be approved following a prescribed procedure where after a certificate of conformance is issued. The procedure involves the official inspection of the vehicle, focusing on issues affecting critical safety, health and environmental characteristics of the vehicles and their components (NRCS, 2020).

While safety, health and environmental issues cannot be ignored, new inventions require massive support to reduce development costs. Some of the challenges cited by Van Tonder (2019) relate to the lack of infrastructure and resources to support new products such as electrical and autonomous vehicles as well as alternative fuel vehicles. Other challenges include:

- ❒ Online trading of regulated products – this issue relates to the imbalances regarding the safety of similar vehicle models supplied in developed countries and in developing countries.
- ❒ Insufficient and/ or outdated technical services limit the ability to test against latest editions of UN Regulations, including approval of technical services as per the

requirements of the 1958 agreement. The high level of service supplied by Technical Services, has continued to fluctuate, with the non-availability of accredited technical facilities hampering the implementation of the Type Approval process.

- Currently, the requirement for vehicle homologation in South Africa has a turnaround time of up to 120 days, hence leading to longer approvals (Van Tonder, 2019).

South Africa, according to Barnes et al. (2018), needs to setup advanced product testing and automotive homologation centres, which will allow the local automotive industry to compete with its leading international competitors. Another concern relates to higher costs associated with homologation of new inventions. These are costs associated with testing and verification, especially for new players in the green vehicle space, that fall in the small, medium to micro enterprise (SMME) category. The exception is large international automotive OEMs, as these already have resources. Besides the negative aspects presented in this sub-section, there are examples of positive measures in South Africa and these are discussed in the following sub-section.

5.5.2. Measures expediting technology switch

These measures can be linked to the success of government interventionist approaches discussed in Chapter Three. What is important about this section is that it highlights measures that are available to consumers and producers of transport greening goods and services in a manner that seeks to counterbalance the limitations discussed in the preceding sub-section. The tricky part seems to be related to how consumers and producers position themselves along these measures.

5.5.2.1. Relaxed trade on green automotive components.

Automobile components, as noted in the Department of Trade and Industry (2017), receive preferential treatment in the Government automotive support schemes. This was depicted in Table 5.4, which indicated rebates of between18-20% (under the Volume Assembly Allowance) on the wholesale price, rebated against the duty payable on imported components used in producing vehicles locally. Also, the Automotive Investment Scheme pays cash benefits (a total of between 20% and 30% for three years) to qualifying auto component suppliers (Bosman, 2019). It is argued in this research that this support is provided irrespective of whether the components are to be used in green or in non-green automobiles. South Africa has also adopted a generally more relaxed trading environment on specific green components and fuels with countries from the EU, EFTA and SADC regions. Most green auto products from these regions are allowed to enter South Africa with reduced or no tariffs or duties. This is true for lithium ion batteries, compressed steel and aluminum gas containers, fuel cells, biodiesel and all petroleum gases as well as hydrogen gas as provided for in the Customs & Excise Tariff Book (SARS, 2018). Relaxed trade, as explained in Radcliffe (2017), encourages more uptake of imported goods due to the reduced prices that come with it. Indeed, South Africa does not have a well-established industry in these sub-sectors. However, much work is currently underway to grow green automobile component manufacturers, including the beneficiation of relevant minerals to produce EV batteries and fuel cells (IDC and **the dti**, 2017). As noted in Bosman (2019), companies like Metair and others have taken steps to investigate the possibility of investing in the manufacture of batteries for EVs.

When viewed from a local industry development point of view, relaxed trade leaves emerging producers of these products exposed to high competition with well-established players from the EU and EFTA regions in particular. Bosman (2019) tried to highlight this point, using lead acid batteries from South Korea where manufacturers are claimed to be receiving some financial support from the state. However, from technological and environmental perspectives, the import of cheap components for green automobiles should encourage local innovative ideas. Examples here include cases described in Freedom Won (2015), the uYilo programme in Autolive (2015) and the City of Johannesburg CNG bus programme reported in the Sandton Chronicle (2014). These programmes involve the conversion of used vehicles to electric and/ or dual-fuels, using imported green kits, e.g. lithium ion batteries, gas tanks and other components. This in turn helps raise awareness, building local capabilities, while also encouraging use of low carbon automobiles. Another support measure related to trade liberalisation, is preferential treatment given to automobiles emanating from the European Union. This is discussed in the next sub-section.

5.5.2.2. Abolishment of import duties under the TDCA

In 2009, the European Union signed the Agreement on Trade, Development and Cooperation (TDCA), with the Republic of South Africa, which came into effect on 1 January 2000. This agreement included establishing a free trade area that covers 90% of bilateral trade between the EU and South Africa (European Commission, 2020). This agreement has provisionally been replaced by the EU-SADC Economic Partnership Agreement (EPA), which now includes five other SADC countries (Botswana, Lesotho, Mozambique, Namibia, and Swaziland). Pending ratification by all EU Member States, the agreement came provisionally into force as of 10 October 2016. In its May 2020 overview of the EPA agreements, the European Commission (2020) indicated that once ratified by all EU member states, the EU-SADC EPA will come into full force on a date that is still to be identified). This gives the impression that this agreement is not yet in full force. Nonetheless, a closer look at the outgoing TDCA, reveals provisions for automotive tariff elimination by South Africa, which appear under Annex III, List 4 (Industrial products, and in this context, automobiles designed to carry passengers). The provision stipulates that duties applicable to these goods shall be phased out by first reducing the duty to 38% of the basic duty, nine years after the coming into effect of the agreement. After this, a further abolition of all other duties would follow twelve years later, from the date of coming into effect of the agreement

(Official Journal of the European Communities, 1999). One of the goods that has since enjoyed a zero import duty under this agreement is the under 1000cc small Internal Combustion Engine (ICE) vehicles. Statistics indicate that the import of this budget segment has risen rapidly in the past five years in South Africa partly due to (Quantec, 2018) the decision between South Africa and the European Commission to set the rate of duty at 0%. Figure 5.5 shows this rise, which has caused both panic and dissatisfaction by certain decision makers in the economic cluster.

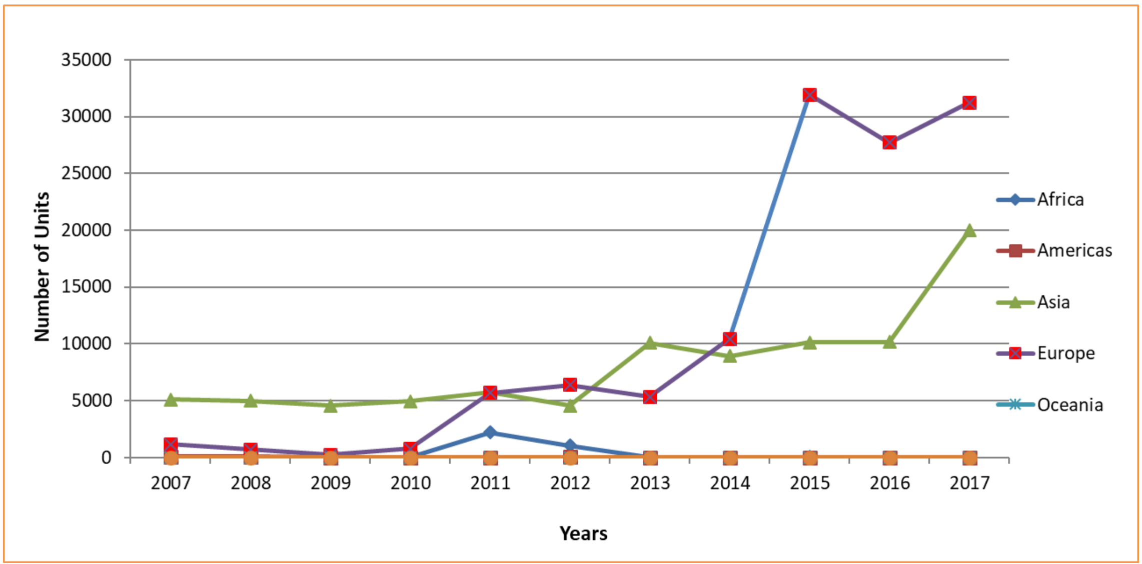

Figure 5.5: Number of under 1000cc vehicles imported to South Africa (by author from Quantec, 2018)

The sharp increase is viewed as a serious threat post-2020 to the old, well-established, well-performing and well-subsidised conventional local automotive manufacturing industry. This early abolishment of import duties seems to have led to many challenges to the country's regulatory authorities. These challenges were raised in a media statement by the then Minister of Trade and Industry, Davis (2018) on 23 November 2018, regarding the South African Automotive Masterplan (SAAM) 2035. The statement raised a clear concern about the misalignment of duties on CBU (Completely Built Up) automobiles emanating from the European Union. Subject to engagements with the EU, the statement recommends harmonisation/ alignment of CBU duties from the EU-SA economic partnership agreement. The form of this harmonisation depends on the outcome of negotiations between the European community and the Republic of South Africa.

As indicated in the Official Journal of the European Communities (1999), the year 2021 under the TDCA will mark the end of trade barriers between these two regions, with respect to automobiles. With so many vehicle units having entered the South African market as depicted in Figure 5.5, it remains to be seen if the EU is going to agree on the harmonisation proposal. The possible proposal by South Africa is to bring all vehicles of the affected category to 18% duties in alignment with the conventional vehicles falling under this category. This means bringing down duties on electric vehicles from 25% to 18% and the 1000cc vehicles up from 0% to 18% (Engineering News, 2018). It should be noted that under the current agreement, it is only by 2021 that all import duties of the vehicle categories under discussion have to be completely abolished. This observed increase of small vehicles from the EU should however give early lessons to the local auto industry on what could happen 12 years from 2009, when all duties on vehicles within this category are abolished in accordance with the TDCA. South African automobile manufacturers could face tough competition from their EU counterparts, which in turn may force them to consider measures to cope with the transition in the form of either manufacturing low carbon vehicles, moving out of the EU market or requesting further amendment of the 2009 agreement. As indicated earlier in this section, the TDCA will be replaced by the provisional EU-SADC EPA, pending the ratification of this agreement by all EU member states (European Commission, 2020).

The impacts of trade liberalisation were discussed in sub-section 5.5.1.1 and depicted using the simple demand and supply curves by Radcliffe (2017). This discussion is not repeated here, however it is important to emphasise that trade liberalisation gives South African consumers a chance to choose from a variety of automobile technologies, not readily available in the country. This includes choices on green automobiles required in the fight against transport related pollution. Nonetheless, besides the relaxation of trade in automobile products and components as discussed in the preceding sub-sections, some of these transport goods are capable of enjoying further rebates in this country. These are rebates and refunds of Customs Duties, Excise Duties, Fuel Levy, Road Accident Fund Levy, Environmental Levy and Health Promotion Levy as provided for in the Customs & Excise Act (Act No. 91 of 1964) published in the Government Gazette (Gazette No. 866 of 1964). The applicable rebates are discussed in the next sub-section.

5.5.2.3. Rebates and refunds of Customs Duties on automotive products and components

In terms of Schedule 4 / Part 1 of the tariff book dated 10/08/2018, rebates (full or partial) apply to goods falling within the categories described in Table 5.5. While these rebates may look generic on certain items such as specialised automobiles for people with disabilities as well as motor vehicle components, other items specific to green transport-related goods include battery electric vehicles of category 8703.90.90 listed in Table 5.5. In Table 5.5, the assumption is that green products are implicitly included in items not stated in Schedule 4, for example, the chassis referred to could also include those of green vehicles such as CNG or electric powered vehicles.

Table 5.5: Rebates in terms of Schedule 4/Part 1 of the Customs & Excise Tariff Book (SARS, 2018)

Rebate type	Description	Tariff heading	Rate of rebate
'Vehicles, aircraft, vessels and associated transport equipment'	**Motor vehicles for the transport of 10 or more people** • 8702.10.81,8702.10.85, 8702.10.87, 8702.90.81(diesel/semidiesel) • 8702.90.85, 8702.90.87 (Battery electric only) **Passenger vehicles** • 8703.21.90 (below 1000 cc petrol) • 8703.90.90 (Battery electric only) **Chassis** 8706.00.05 and 8706.00.15 ('Chassis fitted with engines for motor vehicles of headings 87.01 to 87.05')	87.00	'Full duty less the duty in Section B of Part 2 of Schedule No. 1' 'This applies to vehicles entered on or before **31 December 2015** for the purposes of this item, specified by the International Trade Administration Commission, by means of a certificate'
	'Motor vehicles principally designed for the transport of physically disabled persons, including station wagons (excluding racing cars)'	87.00	Full duty
	'Automotive components for specified motor vehicles, as defined in rebate item 317.03 or heavy motor vehicles'	00.00	'Not exceeding the duty applicable to such goods in Part 1 of Schedule No. 1 calculated on the value reflected on the PRCC'
'Goods for disabled persons or for the upliftment of indigent persons'	'Machines, implements and materials for use in the manufacture of goods by persons with disabilities, subject to the production of a formal certificate confirming that such machines, implements and materials are for the exclusive use by such persons with disabilities, such certificate being endorsed by the International Trade Administration Commission that such or similar goods are not ordinarily nor satisfactorily manufactured in the Republic'	00.00	Full duty
Miscellaneous	'Motor cars manufactured more than 20 years prior to the date of importation'	87.03	'Full duty in Part 1 of Schedule No. 1 less 20%'
'Motor cars imported by refugees from African territories'	'Motor cars imported by refugees from African Territories and which are disposed of by the refugee concerned, provided the prior approval of the Commissioner has been obtained'	87.00	'Full duty less 20%'

Strangely, the rebate system seems to exclude the category of hybrid and fully battery electric vehicles listed below:

- ❒ Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, excluding those capable of being charged by plugging to external source of electric power (8703.40),
- ❒ Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, excluding those capable of being charged by plugging to external source of electric power (8703.50),
- ❒ Other vehicles, with both spark-ignition internal combustion reciprocating piston engine and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power (8703.60),

- Other vehicles, with both compression-ignition internal combustion piston engine (diesel or semi-diesel) and electric motor as motors for propulsion, capable of being charged by plugging to external source of electric power (8703.70),
- Other vehicles, with only electric motor for propulsion (8703.80), and
- Other electric vehicles, of a mass not exceeding 2 000 kg or a G.V.M. not exceeding 3 500 kg or of a mass not exceeding 1 600 kg or a G.V.M. not exceeding 3 500 kg per chassis fitted with a cab (8704.90.40) (SARS Customs & Excise Tariff Book, 2018).

This means that if these green machines are imported from any country other than the EU, EFTA and SADC member states, there is no mercy on the importer. This rebate system extends to other non-green, double and single cabbed vehicles such as those of sub-headings 8704.21.81; 8704.21.83 (diesel and semi-diesel powered) as well as similar size petrol powered vehicles. This is likely to contribute to the conventional vehicle over-subsidisation debate introduced in sub-section 5.5.1.4.

5.5.2.4. Environmental levy on CO_2 emissions of fuel inefficient vehicles

As noted in SARS (2019), an environmental levy (CO_2 tax) is imposed on new passenger vehicles manufactured in South Africa, and that exceed the minimum CO_2 emission threshold of 120g/km. It is designed to influence the composition of this country's vehicle fleet, with the aim of encouraging the purchase of more energy efficient and environmentally friendly vehicles (SARS, 2020). It is a behaviour targeting measure, designed to punish producers of vehicles that emit more carbon dioxide. But as a behaviour changer, this tool has been criticised by Vosper and Mercure (2016), for having failed to alter the behaviour or improve the reduction of emissions of this greenhouse gas. Nonetheless, the levy applies to passenger vehicles, mainly those powered by petrol engines with cylinders ranging in size from below to above 1000cc. As noted in SARS (2019), the penalty was set at a constant rate of R110 per g/km CO_2 emissions exceeding 120g/km for passenger vehicles (as described in the schedule). As published in SCHEDULE 1 / PART 3D of 01 April 2020, SARS (2020) had amended the penalty figures to R120 per g/km CO_2 emissions in vehicles that exceeded the 95g/km CO_2 emission threshold. This signalled a more stringent approach on the part of Government. To arrive at the CO_2 emissions liable for payment of levy, a test report for each vehicle is used. But where such a report is not available, the following formula is to be used to determine the appropriate levy:

- CO_2 emissions (g/km) = 120 + (0.05 x engine capacity in cm^3) if the engine capacity does not exceed 3 000 cm^3.
- CO_2 emissions (g/km) = 175 + (0.05 x engine capacity in cm^3) if the engine capacity exceeds 3 000 cm^3 (SARS, 2019:4-5).

As noted in Vosper and Mercure (2016), vehicles with CO_2 emissions below the threshold are exempt from paying this levy. These vehicles include the BEVs, PHEVs and HEVs. BEVs such as the Leaf, and HEVs such as the Pathfinder according to Group 1 Nissan

(2019) formed part of vehicle groups that were exempt from this type of levy. For goods vehicles, with CO_2 emissions exceeding 175g/km, a hefty penalty of R160 per gram / kilometre CO_2 emissions is imposed on this category of vehicles (SARS, 2020). The larger the vehicle, the higher the levy, and vice versa. This applies to goods vehicles with a mass not exceeding 5 tons or with a Gross Vehicle Mass not exceeding 3500kg.

What SARS (2020) did not include in Schedule 1 / Part 3D of 01 April 2020 is a category for vehicles that transport 10 or more persons, irrespective of fuel used. This includes vehicles of heading 87.02 in the Tariff Book, where these could further be described as buses, coaches and minibus-taxis referred to in Kneale (2016). These vehicles could be powered by diesel only, petrol only, electricity only or by a combination of these fuels. They are however not small and as such are capable of emitting tons of CO_2 into the air. The fact that they are not single occupant vehicles, however, make them fit into the green transportation model depicted in Urban Hub (2020). In other words, there is an element of 'greenness' in them. By virtue of the environmental levy not being imposed on these 'public transport' type of vehicles, in principle, they should be cheaper than the passenger and goods vehicles discussed above. The same should apply to all other energy efficient vehicles such as BEVs, PHEVs and HEVs that emit CO_2 below the set thresholds. It is argued in this sub-section, however, that the impact of import tariffs, as described in Radcliffe (2017), counterbalances the benefit of the environmental levy, with Vosper and Mercure (2016) having noted that this tool has failed to change the behaviour of South African vehicle owners. Nonetheless, this tool provides one of the policy measures made available by the South African Government, in addition to other measures such as those discussed in the next sub-sections.

5.5.2.5. No rules prohibiting conversion of vehicles to green

There is a practice in South Africa (as alluded to in Chapter One) to convert old vehicles to electric or to dual fuelling systems using alternative fuels such as liquefied petroleum gas or compressed natural/ biogases. This included the projects by Freedom Won (2015), the uYilo programme (Autolive, 2015) and the City of Johannesburg CNG bus programme reported (Sandton Chronicle, 2014). These vehicles are on the road and running, and have never been required to undergo homologation processes as prescribed in the relevant technical specifications. Conversion of vehicles of various categories is provided for under the National Regulator for Compulsory Specifications Act (Act No. 5 of 2008) promulgated in the Government Gazette (No. 31216 of 04 July 2008). A closer review of regulatory provisions linked to these specifications revealed that not all converted vehicles require homologation. This is true, especially when a vehicle converter adds new components to an existing chassis from a vehicle that was previously registered in eNATis. The conditions that trigger homologation are well explained in NRCS (2020). They are also described in the various regulations promulgated by the Department of Trade and Industry (2010, 2011, 2014 and 2015) on various categories of vehicles. In these specifications, the key words "existing or previously registered chassis/ bodies" provide guidance on whether or not a vehicle is subject to homologation processes. Based on these words, it is argued in this sub-section that vehicle conversions that involve the use of these bodies/ chassis are not required to undergo any form of homologation processes.

From an environmental perspective, converting a vehicle this way may not be different from applying the waste hierarchy approach well entrenched in the country's Waste Management Act (Act No.59 of 2008) as published in Government Gazette (Gazette No. 32000 of 2008). It is a recycling process which, if done properly, has implications for resource minimisation, reducing reliance on virgin material that goes into a new vehicle. Once converted, such vehicles have potential to mitigate against adverse impacts associated with end of pipe vehicular emissions as they will be using alternative green technologies.

It is argued in this sub-section, however, that even though the modification of these conventional vehicles to greener alternatives, constitutes good environmental practice, there are gaps in the process. While it is positive that they do not require homologation in accordance with current provisions in the compulsory specifications, this also highlights challenges inherent within the NRCS processes. These challenges, as highlighted in Barnes et al. (2018) and Van Tonder (2019), include a need to update the compulsory specifications, in order to keep up with developments in the automotive industry. They also include a need to address the importation of automotive components that are traded online without verified quality standards, as well as a need to set up advanced product testing infrastructure. Safety checks are lacking when it comes to the conversion of these vehicles. A visit to some of the converting workshops in 2017 by the author revealed vehicles fitted with lithium-ion batteries in areas that are not generally designed for batteries. The same applies to components for vehicles converted to run on CNG, e.g. the location of compressed gas containers. When these vehicles are converted, whatever space is available is used for conversion kits. Without proper rules/ guidelines/ standards to guide safe fitting of these components, the safety of these vehicles when driven on public roads, cannot be guaranteed.

Besides the lack of rules prohibiting the conversion of conventional vehicles to green alternatives, South Africa has designated specific zones, with specialised incentives to encourage local manufacturing of specific products. A number of local automobile assembling companies are located within some of these regions as discussed in the next section.

5.5.2.6. Green Technology Special Economic Zones (SEZs)

The Regional Industrial Development Act (Act No. 187 of 1993), often cited in policy documents as the Manufacturing Development Act, was developed to allow the setting up of programmes for regional industrial development. One of the programmes promoted through this Act is the Industrial Development Zones (IDZs) and the Industrial Parks. These include the East London IDZ, the Coega IDZ and the Automotive Industry Development Centre (AIDC), which house some of the major auto manufacturing and component supplying companies in South Africa (ELIDZ SOC Ltd, 2020; Coeqa Development Corporation (Pty) Ltd, 2020; AIDC, 2019). Incentives offered in an IDZ, include the following:

- ❒ Affordable land and buildings for lease,
- ❒ Shared telecommunication networks,
- ❒ Shared 24-hour security and other services in an enclosed and fenced off area,
- ❒ Municipal services of world class standard,
- ❒ Assistance to access investor support and incentives available from national, provincial and local government,
- ❒ Option to locate in a customs controlled area (CCA) offering duty and VAT suspension, and
- ❒ A basket of other investor services including worker recruitment and training to address the specific needs of each investor (Coeqa Development Corporation, 2020).

A Special Economic Zone (SEZ), Atlantis, was officially set aside as a hub to manufacture greener technologies for renewable energy and other green economy sub-categories, in the Western Cape (**the dti**, 2018). This paves the way for the industry that will manufacture components and products required in South Africa’s switch to greener alternatives, including transport industry greening. With the incentives or benefits that come with locating one’s entities within such zones, green transport related entities might find their way here in the near future. Promulgated in the Government Gazette (Gazette No. 39667 of 2014), the Special Economic Zone Act (Act No. 16 of 2014) specifies that businesses located within the SEZ may qualify for prescribed incentives including tax relief and other measures.

Besides the IDZ and the SEZ programmes discussed in this section, as well as the APDP programme discussed in sub-section 5.5.1.4, the Electric Vehicle Industry Roadmap as well as the South African Automotive Master Plan (SAAM2035) contain aspects that introduce greening language in South Africa’s automotive manufacturing industry. Both programmes are discussed in the next sub-section.

5.5.2.7. The EV Roadmap and the SAAM2035

Much was written in section 5.5.4.1 about various financial incentives, which it was argued, favour the status quo inclined towards the conventional ICE automobiles. It was also argued that, even though these financial incentives do not explicitly exclude green automobiles, the criteria set, e.g. the 50000 minimum threshold, automatically throw out prospective players in the energy efficient and less polluting vehicle manufacturing space. There have been attempts however to introduce measures that directly support the transition. One notable attempt was Government's development and launching of the South African Electric Vehicle Industry Road Map (EV Roadmap). Already alluded to in Chapter Two, where ERC (2013) criticised the Department of Transport for supporting electro-mobility, but not prioritising electric vehicles. ERC also criticised the Department of Trade and Industry's automobile incentive scheme, for making no specific reference to electric vehicles. The EV Roadmap was developed in 2012 to support local manufacturing of electric vehicles (Department of Trade and Industry, 2013). It marked the first policy attempt to improve the automotive support schemes introduced in sub-section 5.5.1.4, encouraging local manufacture and adoption of greener vehicles. Launched between the departments of Trade and Industry, Environmental Affairs, and Science and Technology, this roadmap contained the following key aspects, which signalled Government's desire to shift policy thinking towards eco-mobility:

- State procurement – create demand for EVs by including them in Government vehicle procurement strategies.
- Investment support – include EVs in the qualification criteria of the Automotive Production Development Programme (APDP).
- Research and development – increase research and development (R&D) funds.
- Awareness and public education – embark on awareness campaigns on the benefits of using EVs.
- Carbon taxation – provide tax rebates on EV owners with CO_2 emissions below the 120 g/km emission threshold (Department of Trade and Industry, 2013).

What can be deduced from this policy position of Government is that the roadmap was biased towards one automobile greening technology, i.e. electric vehicles. In other words it faces the same criticism as the APPD, which seemed biased towards the ICE automobiles. The EV Road Map ignored the availability of other greener technologies already adopted in leading green transportation countries. These technologies include various efficiency improvement measures in ICEs, use of alternative fuel vehicles such as those powered by biofuels and compressed gases. These technologies were discussed in various literature documents in the previous chapters, including Nesbit et al. (2016) on efficiency improvements; IANGV (2018) on NGVs; Charis, Danha and Muzenda (2018) on biofuels and Posada (2018) on fuel economy. Also, there is no readily available evidence of how the EV Roadmap was approved at cabinet level, in accordance with South Africa's cooperative governance principles, given the financial implications associated with its implementation by other organs of state. The only known approval occurred within the Department of Trade and Industry.

Another key aspect of the roadmap is that it adopted an approach that sought to stimulate both the demand and supply sides. As such it seems unique compared to the approaches adopted in China, USA and Norway. As noted in Ou et al. (2019); Hardman et al. (2018);

Yingqun (2017); Forbes Media LLC (2017); Center for Climate and Energy Solutions (2019), either one of the measures (the demand-pull or the supply-push measures) dominated at any given point in time in these countries. While the roadmap, as noted in ERC (2013), has been criticised for not having led to any remarkable progress, it is worth noting progress made by the Department of Science and Technology through its agency (Technology Innovation Agency) and the agency's uYilo programme. It is argued in this section that the uYilo programme has done much to facilitate programmes linked to the third and fourth bullet points above. As noted in Parmar (2018), uYilo's e-mobility programme eco-system involves ongoing research efforts to enhance the uptake of EVs, battery technology, charging infrastructure and smart grids. Awareness raising is done in collaboration with other institutions such as the Nelson Mandela University, the Electric Vehicle Industry Alliance, the Department of Trade and Industry, the South African National Energy Development Institute, the Department of Energy and key automotive OEMs including Nissan and BMW (Parmar, 2018).

While the implementation of other aspects of the EV roadmap have not progressed much, it is argued here that they are slowly being incorporated into various policies and programmes of Government. This includes the Green Transport Strategy, which as noted in DoT (2018), has set targets for South Africa to develop guidelines for state procurement of green automobiles, including EVs. Published in the Government Gazette (Gazette No. 42483 of 2019), South Africa's Carbon Tax Act (Act No. 15 of 2019) contains provisions that do not specifically provide tax rebates to EV owners as envisaged in the EV Road Map. However, it amends Schedule 3 of the Customs and Excise Act (Act No. 91 of 1964) which involves absorbing the Environment Levy provisions contained in Section 1, Schedule 3. As noted in SARS (2020), this levy is now more stringent with a penalty of R120 per g/km CO_2 emissions on passenger vehicles that exceeds the 95g/km CO_2 emission threshold. This threshold has been reduced significantly from 120g/km CO_2 emissions in 2019. These are however, only penalties to the consumers of polluting vehicles, not rebates to the consumers of EVs as hoped for by the EV Roadmap. Regarding the proposal in the EV roadmap to have EVs included in the qualification criteria of the Automotive Production Development Programme (APDP), this is discussed in the following paragraph which briefly examines South Africa's Automotive Master Plan from the period 2020 to 2035.

The South African Automotive Master Plan (SAAM 2035) has been developed in collaboration between Government, industry and organised labour and was publicly announced on 23 November 2018 (Barnes et al., 2018). This scheme replaces the APDP which, as noted in Table 5.4 (**the dti,** 2017), expires in 2020, with the following vision:

> A globally competitive and transformed industry that actively contributes to the sustainable development of South Africa's productive economy, creating prosperity for industry stakeholders and broader society (Barnes, et al: 2018: 18).

One of the four components of the SAAM 2035 vision relates to a need to develop South Africa's economic system, taking into consideration sustainable development principles. It seeks to grow the industry, provide employment and develop skills with potential to stimulate improvements in the ecological footprint of automotive goods and services (Barnes and Black, 2017). The latter talks to the greening aspects envisaged by this new plan. It also relates to one of the six industry development pillars that this automotive plan intends to prioritise, i.e. technology and associated skills development. This pillar recognises the following:

> As product development and production processes within the automotive industry become more environmentally sustainable, there will also be clear requirements for the deployment of new production technologies in South Africa. These may require new types of industrial infrastructure that need to be understood and responded to, to ensure South Africa does not fall too far behind the automotive technology frontier, and that domestic production continues to qualify for supply into developed economy markets with ever-more demanding environmental requirements that are likely to represent new forms of Non-Trade Barriers in future. To realise its full potential, South Africa also has a discreet set of automotive-linked materials supply that will need to be developed in alignment with the evolution of new automotive technologies. These materials, including Platinum Group Metals, aluminium, and certain grades of steel, represent core areas of potential sustained competitive advantage for the South African automotive industry. It is therefore essential that base South African capabilities are advanced across these core materials in support of automotive industry requirements through to 2035 (Barnes, et al: 2018: 29).

SAAM's mention of a need to develop a globally competitive automotive industry that contributes to sustainable development, has implications for greening. In 2018, the export of passenger cars and light commercial vehicles accounted for over 60% of total domestic passenger and light vehicle production (Automotive Industry Export Council, 2019). These were exported to different parts of the world, with the European Union having dominated the export market at 58% in 2018. Due to the South African economies of scale having generally remained insufficient, exporting, according to the Automotive Industry Export Council (2019), remains key to improving international competitiveness. However, Posada (2018) noted that EU member states operate within very strict fuel economy standards. These standards continue to be used as barriers to entry to these markets. As such, some of these countries have set stringent targets to ban the use of ICEs and rolling out of energy efficient vehicles, including EVs. As noted in Barnes et al. (2018), SAAM introduces the concept of Energy Efficient Vehicles (EEVs). In terms of emerging technology changes, these writers caution how critical it is for South Africa to invest in alternative technology infrastructure to enable the transition to EEVs. This will initially follow a hybrid-Internal Combustion Engine (ICE) route, such as the use of Plug-in Hybrid Electric Vehicles (PHEVs), followed by battery-electric and hydrogen vehicles. As such, it is argued in this sub-section that the EEV Roadmap proposal calls for efficiency measures which seem broader than South Africa's EV Roadmap. But how is this thinking going to be translated into action?

On 25 February 2020, the Chief Executive Officer of NAAMSA, Mr Mike Mabasa, was quoted on Engineering News (2020) as saying that the automotive industry is working with Government to develop a position paper on electric vehicles. This work entails engagement with the following five themes:

- *Production* – this aspect recognises that South Africa is the biggest producer of automobiles in the continent, and as such, it is crucial for South African producers to have clear insights on the implications of migrating to EV production. This part of the position paper will provide such insight, especially in context of 60% of locally produced vehicles going to the export market (with 58% of this going to Europe).
- *Charging infrastructure* – this seeks to get better understanding of infrastructure funding and roll-out models, as well as players in the market and infrastructure needs. This theme recognises the size of and nature of geographic spread of South Africa's cities, emphasising the importance of ensuring that the EV revolution is not limited to cities only, but that, it should also reach out to small towns.
- *Incentive programmes* – this will focus on the demand-pull measures, clarifying the extent to which Government will incentivise the industry, given the relatively expensive EVs imported from abroad at 25% import tariff.
- *Regulatory environment* – while this theme is closely linked to the previous theme, it will focus on the supply-push side, examining how conducive it may be to promote and build EVs locally.
- *Research and development* – this is the last focus area in the position paper, seeking to clarify how South Africa can contribute to the global EV ecosystem, beneficiating locally mined minerals to enhance battery technology (Engineering News, 2020).

Developed in partnership between the industry and the Department of Trade and Industry, the position paper should provide insights on potential policy measures that Government can take. In addition, it should be used by local automotive industry as an advocacy tool to lobby not only to Government, but also their parent companies for a share of future EV production (Engineering News, 2020). There seem to be synergies between the EV Roadmap, the SAAM2035 recommendations and the move by the industry-government partnership as alluded to in this revelation by Engineering News. It is argued in this chapter that, while this joint effort between industry and Government is acknowledged, only time will tell how the partnership will pan out in the context of ongoing efforts to promote technology switches with the aim of encouraging a just transition to a low pollution and low carbon economy. Technology switches alone have no meaning, if they are not accompanied by a switch to fuels that are appropriate for these new technologies. In their study of electric vehicle usage in Norway, Aasness and Odeck (2015), cautioned that the potential reduction in carbon dioxide emissions by EVs depends on the source of electricity used. In areas where electricity used to charge EVs, comes from fossil fuels such as coal, EVs perform more poorly than the most fuel-efficient gasoline cars. Aasness and Odeck's comparison was between Norway and China, where the latter uses fossil fuels, with the former using renewable energy such as hydro power to fuel the EVs. The following section examines South Africa's policy, regulatory and legislative responses to fuel switch.

5.6. POLICY PROVISIONS RELATING TO FUEL SWITCH

This section focuses on legislative provisions that would promote or hinder a fuel switch. By fuel switch is meant the shift from use of traditional fossil-based petroleum fuels, to the use of greener fuels such as electricity, biological fuels (in liquid or in gaseous form), and hydrogen as it is used in fuel cell technologies. As transitional fuels, Compressed Natural Gas (CNG) as well as Liquefied Petroleum Gas (LPG), also form part of the discussion. Brinson (2020) refers to CNG and LPG as transitional fuels since they provide a bridge between fossil energy and the use of more environmentally friendly renewable energy types. Prior to discussing legislative provisions relating to these alternative fuels, it is important to first remind the reader (as discussed in Chapter One) that local fuel prices, are dependent on many factors, including global influences. Specifically, these factors include to a larger extent, crude oil price fluctuations, the exchange rate at any given point in time and any other demand and supply interactions (DoE, 2018).

The final price at the pump station is, however, determined through a process regulated by Government. In its Discussion Document on the Review of the Basic Fuel Prices (BFPs) Structures, the Department of Energy (2018) noted that the regulation of petroleum products prices and or some control of the prices helps protect consumers against high prices and ensures that the markets develop in an orderly manner. There is hence a range of taxes which, as was noted around July/August 2018, attracted media and political attention when for the first time in the history of fuel prices in this country, the rand/per litre price exceeded seventeen rand (Head, 2019). While Government does not have control over international market forces which impact on the Rand/Dollar relationship and the decisions by oil cartels, it does control all other levies currently imposed on the price of petrol and diesel available at the country's fuelling stations. In addition, Government has subsidised this industry since around 1954, initially through the South African Torbanite Mining and Refining (SATMAR) Company in Boksburg (Lott, 2016). These are subsidies which were a starting point to future Government financial support, including later support to Sasol and PetroSA (former Mossgas) (Lott, 2016).

5.6.1. General duties and levies on fuels

Two main legislative frameworks governing fuel pricing in South Africa include the Central Energy Fund Act (Act No. 38 of 1977) and the Customs and Excise Act (Act No. 61 of 1964).

While the former regulates taxation of fuel through the imposition of applicable levies, the latter controls duties/ tariffs on imported fuels. The collected revenues are gathered and stored in a central fund designed to support energy related projects. With South Africa's increasing adoption of renewable energy, as noted in the Department of Energy (2019), the Integrated Resource Plan (IRP2019) recognises different types of renewable energy sources and technologies, as critical components to form part of this country's energy mix. This is a very important issue in the context of the technology switch discussed in the preceding section. Depending on the location of the users, the type of fuel they prefer, transportation fuels used in this country are subjected to a range of costs as portrayed in Figure 5.6. The Fuel Levy and the Road Accident Fund (RAF) Levy as indicated above is imposed on this price in accordance with provisions in the Central Energy Fund Act (Act No. 38 of 1977). Figure 5.6 shows that the basic fuel price share in the total cost of fuel was only around 40% in August 2017 and 47% in the same month in 2018. Based on the evaluation of numbers in Figure 5.6, as derived from the Central Energy Fund (CEF, 2017 and 2018), about 60% and 53% respectively of the total price of fuel was attributed to additional costs imposed by Government in the form of taxes. The fuel levy and the road accident fund levy continue to account for the biggest portion of fuel costs.

COMPOSITION OF THE RETAIL PRICE OF PETROL AND THE WHOLESALE PRICES FOR DIESEL AND IP IN GAUTENG FOR THE PERIOD 01/08/2018 TO 04/09/2018 WILL BE AS FOLLOWS:

	Petrol 95 ULP c/l	Petrol 93 ULP & LRP c/l	Diesel 0.05% S c/l	Diesel 0.005% S c/l	Illumi-nating Paraffin c/l
Wholesale margin	34.000	34.000	67.660	67.660	67.660
Secondary Storage	18.600	18.600	18.600	18.600	18.600
Secondary Distribution	15.900	15.900	15.900	15.900	15.900
Router Differential	0.000	0.000	0.000	0.000	7.400
Retail margin	187.200	187.200	0.000	0.000	0.000
Zone differential in Gauteng	51.700	51.700	51.700	51.700	63.400
IP Tracer levy	0.000	0.000	0.010	0.010	0.000
Fuel levy	337.000	337.000	322.000	322.000	0.000
Customs & excise duty	4.000	4.000	4.000	4.000	0.000
RAF levy	193.000	193.000	193.000	193.000	0.000
Petroleum Products levy	0.330	0.330	0.330	0.330	0.000
Slate levy	0.000	0.000	0.000	0.000	0.000
DSML	10.000	0.000	0.000	0.000	0.000
Equalisation Fund Levy	0.000	0.000	0.000	0.000	0.000
Pump Rounding	0.200	0.200	0.000	0.000	0.000
Sub-total	851.930	841.930	673.200	673.200	172.960
Contribution to the Basic Fuel Price	751.070	739.070	767.630	772.030	780.128
Retail Price	1,603.00	1,581.00			
Wholesale price			1,440.830	1,445.230	953.088

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COMPOSITION OF THE RETAIL PRICE OF PETROL AND THE WHOLESALE PRICES FOR DIESEL AND IP IN GAUTENG FOR THE PERIOD 02/08/2017 TO 05/09/2017 WILL BE AS FOLLOWS:

	Petrol 95 ULP c/l	Petrol 93 ULP & LRP c/l	Diesel 0.05% S c/l	Diesel 0.005% S c/l	Illumi-nating Paraffin c/l
Wholesale margin	35.600	35.600	67.660	67.660	67.660
Secondary Storage	17.900	17.900	17.900	17.900	17.900
Secondary Distribution	17.300	17.300	17.300	17.300	17.300
Router Differential	0.000	0.000	0.000	0.000	7.400
Retail margin	176.400	176.400	0.000	0.000	0.000
Zone differential in Gauteng	41.500	41.500	41.500	41.500	60.700
IP Tracer levy	0.000	0.000	0.010	0.010	0.000
Fuel levy	315.000	315.000	300.000	300.000	0.000
Customs & excise duty	4.000	4.000	4.000	4.000	0.000
RAF levy	163.000	163.000	163.000	163.000	0.000
Petroleum Products levy	0.330	0.330	0.330	0.330	0.000
Slate levy	0.000	0.000	0.000	0.000	0.000
DSML	10.000	0.000	0.000	0.000	0.000
Equalisation Fund Levy	0.000	0.000	0.000	0.000	0.000
Pump Rounding	0.300	0.300			
Sub-total	781.330	771.330	611.700	611.700	170.960
Contribution to the Basic Fuel Price	523.670	510.670	514.630	520.030	512.128
Retail Price	1,305.00	1,282.00			
Wholesale price			1,126.330	1,131.730	683.088

B.

Figure 5.6: Fuel pricing in South Africa (source: CEF, 2017 and 2018)

South Africa (as discussed in Chapter One) sources most of its transportation fuels from fossils, largely in the form of crude oil, finished petroleum products and natural gas imports. In accordance with provisions in the Customs and Excise Act introduced above, these products are subject to the payment of Customs and Excise Duties if consumed within the borders of this country (SARS, 2018). If sold to any of the other Southern African Customs Union (SACU) Member States, only the Excise Duty applies, with all other levies indicated in Figure 5.6, not applying (SARS, 2018). This means that South Africa's fuel could be more expensive than fuel used in the SACU member states (provided these states do not have their own levies).

Besides the Central Energy Fund Act and Customs and Excise Act, transport fuels in South Africa are also regulated under the Petroleum Products Act (Act No. 120 of 1977), which provides a framework for the generation, sale and consumption of petroleum products in the country. Legislative frameworks related to mineral resource mining also have relevance here, especially in the context of coal, oil and gas as well as many other minerals used to generate renewable energy resources. The main foundation for the transport energy related legislative framework in South Africa hence includes these legislative frameworks and related regulations such as the Regulations for Mandatory Blending of Biofuels with Petrol and Diesel (Gazette No. 31575 of 2012). Other key legislative frameworks are the Gas Act (Act No.48 of 2001), the National Energy Act (Act No. 34 of 2008) as well as the Electricity Act (Act No. 41 of 1987). All these legislative frameworks, their amended versions and associated regulations, have relevance to the debates around the fuel switch to green alternatives, and hence are a focus of discussion in the subsequent sections.

5.6.2. Measures promoting alternative fuels

This section introduces the work of the Presidential Infrastructure Coordinating Commission (PICC). SIP 8 (one of the 18 Strategic Infrastructure Programmes), in particular, focuses on the support rendered to sustainable green energy initiatives incorporated into the resource plan for electricity generation as well as assistance provided to those companies willing to manufacture biologically based liquid and gaseous fuels (PICC, 2011). On the South African Government's website, the Department of Economic Development (2017) showed progress in renewable energy, with 6376MW procured from independent power producers, but said nothing about the biofuels industry. Also, the energy referred to on this website is electricity generation for conventional use – not specifically to power electric vehicles. The next sub-section provides an overview of measures available in South Africa, and that support the transition to alternative fuels.

5.6.2.1. Rebates and refunds on biodiesel

The 75th Section of South Africa's Customs and Excise Act makes provisions for rebates, drawbacks and refunds of duties applicable to imported products to the RSA. One product included is biodiesel (Customs and Excise Act, No. 61 of 1964). In addition, the South African Revenue Services, has developed the diesel/biodiesel reference guide (SARS, 2017). This living document is amended from time to time to ensure alignment with the legislative framework. As in April 2017, qualifying entities, falling within specified categories, could apply for the refund as described in Table 5.6.

Table 5.6: The biodiesel rebate system (National Treasury and SARS, 2017)

Applicable area	Description
Land farming, forestry or mining	❐ The rebate goes as follows: 120 cents per litre fuel levy (FL) on 80% of eligible purchases, plus 163 cents/ per litre Road Accident Fund (RAF) levy on 80% of eligible purchases. For 1 000 litres eligible purchases, the calculation goes as follows: 1000 x 80% equals 800 litres. A refund of 283 cents/ litre may therefore be claimed; For 1 000 litres purchased of which 300 litres represent non-eligible purchases, for example, carriage of goods for reward - 1 000 litres less 300 litres equals 700 litres eligible purchases x 80% equals 560 litres on which a refund of 283 cents per litre may be claimed. There is a 50% exemption for biodiesel, where non-commercial manufacturers producing below 25 thousand litres/ month are exempted from paying the fuel levy.
Offshore vessels	❐ For these vessels, the rebate is 300cents/ per litre (fuel levy) and a rebate on RAF, similar to the category above.
Harbour vessels	❐ Vessels operated by Portnet including vessels used by in-port bunker barge operators do not pay RAF.
Rail	❐ This refers to locomotives used for rail freight, excluding those used in the first category above. These do not pay RAF too.
Electricity generation plants	❐ Distillate fuel used solely as fuel in electricity generation plants with a capacity exceeding 200megawatt per plant, generating electricity for the national distribution network get 150 cents/per litre exemption (fuel levy) as well as no RAF.

More details on the process that qualifying entities should follow when wishing to apply for these refunds, is detailed in SARS (2019). The diesel refund system, however, seems to have experienced a number of challenges lately as can be noted in the quote extracted from the 2015 Budget Review of National Treasury:

> The administrative system in place since 2000 faces significant technical problems and legal challenges. Some eligible firms are unable to benefit from the system while others appear to be making disproportionate refund claims. To address these concerns, government proposes to delink diesel refunds from the VAT system from 1 April 2016. The National Treasury and SARS will explore alternative, more equitable rules and administrative procedures after consultation with the affected industries. Government also proposes to reduce diesel fuel levy refunds to 20 per cent and 50 per cent of the general fuel levy respectively for on-land mining activities and generation of electricity by Eskom's open cycle gas turbines. The current full exemption provides a perverse incentive to use diesel excessively. This change will become effective from 1 April 2016 (National Treasury, 2015:51).

These challenges were further acknowledged by National Treasury's subsequent initiatives aimed at mitigating against these challenges by reviewing and redesigning the diesel refund system. The draft review as of November 2017 made the following recommendations to the current refund regime: a) the system to target qualifying primary production activities rather than users; b) emphasis on the inclusion of contractors; c) Standalone Diesel Refund Administration System; and d) administrative enforcement and taxpayer compliance (National Treasury and SARS, 2017). Besides the rebate on biodiesel, investing in this fuel is also subject to provisions for accelerated depreciation. This gives businesses a tax and cash flow advantage when setting up projects that produce renewable electricity or biofuels (National Treasury and SARS, 2017).

5.6.2.2. No fuel levy imposed on green fuels

As depicted in the preceding Figure 5.6 derived from CEF (2017 and 2018), the indicated levies are for fossil-derived liquid petrol and diesel, giving the impression that no fuel levies are currently imposed on compressed natural gas, biogas, bio-ethanol and electricity when used to power automobiles. Fuel levies raise the cost of petrol and diesel at the pump and thereby effectively promote the use of greener alternatives. At the time of writing this section in August 2018, the natural gas price at the gas filling station in one of the two most active supplies in the country was around R9.90/ litre. The fuel levy is however applicable to fossil-derived petrol and diesel as well as biodiesel, which are classified as fuel levy goods in terms of Schedule 1 Part 5A of the Customs and Excise Act (Act No. 61 of 1964). This raises the cost of these fuels at the pump thereby effectively promoting other alternative fuels. This Act however says nothing about hydrogen, which is an alternative fuel for vehicles powered by platinum group of metals (PGMs), such as fuel cells. This type of fuel is slowly gaining momentum in South Africa, more especially as increasing emphasis is placed on the mining and local beneficiation of the country's most abundant platinum resource (IDC and **the dti,** 2017). The amount of levy imposed on non-green fuels as indicated above is determined by the Minister of Finance, with adjustments to the tax being announced during the annual budget speech. This creates uncertainty, raising questions about future sustainability of ventures that have already invested in the use of these greener fuels, especially when the Ministry of Finance one day decides to impose a levy on these currently cheap fuels.

5.6.2.3. The RAF – not imposed on Green Fuels

As with the Fuel Levy discussion above and as noted in the media statement by CEF (2017 and 2018), there is no evidence that the Road Accident Fund (RAF) applies to alternatives like natural gas and electricity. As such, this makes these fuels relatively cheaper than their traditional petrol and biodiesel counterparts. Again, there is a policy uncertainty in this area as the status quo creates an impression that such fuels are cheap for use in vehicles. The reality is that they are only cheap because this levy does not apply to them, hence ignoring the question as to which roads vehicles powered by these fuels will be driven on. The Road Accident Fund Act (Act No. 56 of 1996) makes provisions for the development of a fund in the payment of compensation in the case of automobile-accidents occurring on public roads. The Act is under the administration of the Department of Transport. It is applicable in situations where driving is happening on public roads, without specifying the type of vehicle and fuel used (Government Gazette No.17532 of 1996). As of 2017, this levy was not applicable to alternatives fuels like natural gas and electricity. The RAF fund procures the funds it requires to perform its functions by way of a Road Accident Fund levy contemplated in the Customs and Excise Act (1964) and by raising loans. Similar to most levies imposed on various goods and services, money collected this way is channelled into the national pool of funds in accordance with provisions of the Customs and Excise Act. This excludes any amounts paid back in the form of refunds, rebates, etc. The RAF levy is adjusted from time to time, with the amount shown in Figure 5.6 in 2017, set at R163/litre for petrol and diesel. At the time of writing this section in June 2020, this figure was recorded at R2.07/litre (CEF, 2020). This duty is paid on applicable goods including imported and locally produced fuels. Since South Africa imports mostly petroleum fuel, the levy is applicable to this type of fuel. The RAF levy is applicable to petrol and diesel, and like the fuel levy, it increases the cost of these fuels as noted in the media statement by CEF (2020). One issue with this is that in the case of large-scale uptake of alternative fuels, the Road Accident Fund is likely to experience more pressure of underfunding.

5.6.2.4. No duty on green fuels from EU, EFTA and SADC regions

The previous section discussed imported green components. South Africa has also adopted a generally more relaxed trading environment around these components, especially with the EU, EFTA, and SADC regions, as indicated in Table 5.7 below. Most products from these regions are allowed to enter South Africa with reduced or without any tariffs or duties (SARS, 2018). This is true for biodiesel and all petroleum fuels. The challenge is that this leaves emerging local producers of these products vulnerable to unfair competition from well-established players in the EU and EFTA regions in particular. Nonetheless, the relaxed environment should be encouraging increased uptake of such fuels from these countries.

Table 5.7: Import duties on green fuels (Source: SARS Tariff Book, 2018)

Heading/ sub-heading	**Description**	**DUTIES BY REGIONS**				
		General	EU	EFTA	SADC	MERCOSUR
3826.00.10	Biodiesel as defined in Additional Note 1(a) to Chapter 38	0.183c/litre	0	0	0	0.183c/litre
3826.00.90	Other biodiesel	0.183c/litre	0	0	0	0.183c/litre
2207.10	Undenatured ethyl alcohol of an alcoholic strength by volume of 80% vol. or higher	317c/litre	0	317c/litre	0	317c/litre
	Ethyl alcohol and other spirits, denatured, of any strength	317c/litre	0	317c/litre	0	317c/litre
2804.10	Hydrogen	0	0	0	0	0
2711.11	LNG	0	0	0	0	0
2711.12	LPG	0	0	0	0	0
2711.21	CNG	0	0	0	0	0

It was revealed in Chapter Two that the European Union is poised to be the world's biodiesel leading producer by 2024. Since this region enjoys free trade with South Africa as shown in Table 5.7 above, this could jeopardise aspiring local producers of biofuels, especially when these fuels are imported from these regions. A biodiesel importer from Indonesia, Brazil and the US will be disadvantaged while the importer from EU, SADC and EFTA member countries will benefit from zero duties. A certain degree of protection may therefore be necessary should this be raised as a concern, but overall, free trade with the EU could be good for the South African climate and consumers provided that the fuel meet or exceed this country's fuel specifications and prices are good.

5.6.2.5. No customs & excise duty on cleaner fuels

The Customs & Excise Duty is a levy collected in terms of an agreement by the Southern African Customs Union (SACU) (SARS, 2018). It is payable by the manufacturers of fuel goods such as petrol, diesel and biodiesel. It applies if the fuel goods are consumed in the RSA and any SACU member state. This levy slightly increases the price of liquid fuel goods, hence promoting greener alternatives not included under fuel goods such as electricity for EVs, bio-ethanol and natural gas-powered vehicles. Like the Fuel Levy, defining biodiesel as a good fuel while bio-ethanol and gaseous fuels (natural, biogas) are not, creates inequality in the marketplace of low carbon fuels (**the dti,** 2016).

5.6.2.6. Carbon tax indirectly incentivising use of alternative fuels

The initial draft Carbon Tax bill according to National Treasury (2018) was published for public comment in November 2015. Cabinet adopted it in August 2017, with the Minister of Finance in the 2018 Budget Speech proposing 1 January 2019 as the implementation date. The President signed this bill into law in 2019, hence giving birth to the new legislative framework: the Carbon Tax Act (Act No. 15 of 2019). This tax was promulgated in the Government Gazette (Gazette No. 42483 of May 2019), with the main purpose of curbing the emission of gases that contribute to the climate change problem (National Treasury, 2019). It therefore triggers in the polluter-pays-principle, stimulating responses not only from large emitters, but also from consumers of goods and services that contribute to the problem. It therefore seeks to encourage the internalisation of producer and consumer costs, in the process compelling them to alter their behaviour (National Treasury, 2018). It is based on the idea that if a carbon tax underperforms environmentally, it can be amended in a way that it will rise automatically in response to emission trends (National Treasury, 2018). While this kind of belief seems convincing, it leaves many unanswered questions, following the fact that the Plastic Bag Levy had similar intentions – changing consumer behaviour, but was it able to achieve that goal? Another similar tax is the CO_2 tax on new passenger vehicles; whose ability to achieve its stated goal of 'changing behaviour' has been questioned by writers such as Vosper and Mercure (2016).

South Africa's Carbon Tax is designed around tax-free allowances and recycling measures. Some of the revenue recycling measures include improved public passenger transport and support for a modal shift (National Treasury, 2018). It is argued here that this measure will help to promote the modal shift discussed later in this section. It also includes tax incentives on energy efficiency savings. It is not clear if recycling will be able to benefit the use of fuel-efficient vehicles. In an article posted on September 2013, Transport World Africa (2013) engaged in a discussion with Promethium Carbon regarding the implications for carbon tax on the country's transport industries. In response to the question pertaining to the relief measures for the country's local transport industry, including managers of large fleets, the legislative framework categorises this industry as "other". As such, companies involved in international trade may benefit from relief measures of up to 10%. Companies that are only involved in intra-border trade may not benefit from such relief. This institution further argued that possible relief may be obtained on the basis that the current fuels used in South Africa, do not compete with any other alternative fuels. This provides justification for the treatment of resulting emissions, as process emissions (Transport World Africa, 2013). With this argument, the domestic transport companies have the choice to either seek relief from Government or to look for alternative low carbon fuels to power their fleet. Nonetheless, the carbon tax seems to have already started punishing the use of conventional fuels over alternative / green fuels as noted in a media statement issued by the South African Government (2019). Published in May 2019 on the Government website, the statement highlighted how National Treasury would incorporate carbon tax into the fuel price of petroleum products. It was therefore implemented alongside the April 2019 fuel levy increase as follows:

> The carbon tax on fuel will be implemented as an add-on to the general fuel levy, and that South African Revenue Service will publish amendments to the Notes in Part 5A of Schedule No.1 to the Customs and Excise Act, 1964, to give effect to these adjustments (South African Government, 2019).

5.6.2.7. Electricity legislation providing viable yet complicated provisions

The South African decision makers have not yet declared electricity as an energy source for vehicles. At the same time, the Electricity Act (Act No. 41 of 1987), read with the National Energy Regulator Act (No. 40 of 2004) and Section 7 of the Electricity Regulation Act (Act No. 4 of 2006), does not rule out use of electricity for the transport sector. The Electricity Act was designed to control the production as well as the distribution of electricity, among others. It hence makes provisions for the issuing of licenses for the generation, distribution and resale of electricity. A closer look at these legislative frameworks reveals that none of them explicitly exclude electricity generation for use in powering automobiles. In other words, licenses are issued based on the application submitted by the licensee, irrespective of what the final usage of electricity will be.

One challenge relates to when producers of electricity from vehicular public charging points want to engage in energy business by reselling additional power via the grid. There are strict registration requirements with the licenced authority. Plants over 100kw require a licence and compliance with mandated requirements for the licence (**the dti**, 2016). This means that in South Africa one can generate power and resell but under a capped price/ tariff set by the regulator, and from 2011, only through a competitive bidding process. While Section 6 (1) of the Electricity Act stipulates provisions with respect to electricity generation and supply, the Act however still makes provisions for exemption from licences. Schedule 1 of the Electricity Regulation Act (Act No. 4 of 2006) lists activities that are exempted from a requirement to obtain a licence. These include:

- Electricity generating plants that have been designed for demonstration purposes only and which are not connected to the grid,
- Electricity plants developed for own consumption, and
- Electricity supply not connected to the grid, except for commercial purposes.

Electricity distribution in South Africa takes place via the grid or via a decentralised supply in the case of renewable energy like solar PV (**the dti**, 2016). One concern associated with this relates to the electricity network challenges to handle the required load in case of large-scale uptake of electricity to charge vehicles. The sharp decline in renewable energy prices since the inception of the country's Renewable Energy Independent Power Producer Procurement (REIPPP) programme in 2011, coupled with price increases in conventional grid power, makes renewable energy especially solar PV and wind energy relatively attractive. It is argued in this sub-section that these renewable energy technologies are ideal for the so-called 'zero emission' electric vehicles available on the South African market. By charging them on renewable energy fed sockets, these vehicles become 'truly zero emission' vehicles, compared to when charged from fossil-based counterparts. In its Industrial Policy Action Plan (IPAP 2015/16-2017/18), the Department of Trade and Industry (2015) revealed its intentions to support low carbon transportation in South Africa by stating the following:

> Electric vehicles (EVs) present a high potential to reduce GHG emissions, in particular if powered by renewable energy (RE) sources. While certain existing vehicles can easily be converted to methane gas operation, new vehicles and in particular those used for urban commuting and delivery purposes are ideal candidates for battery electric operation (Department of Trade and Industry, 2015:135).

Another prominent driver of energy sustainability is the National Energy Act (Act No. 34 of 2008). It was designed to ensure availability of less costly and enough sources of energy for the benefit of South Africans. The energy resources should support the socio-economic needs including growth in the country's economy as well as alleviation of poverty. It also emphasises a need for South Africa to incorporate environmental protection thinking into economic sector decision-making processes. The Act further makes provisions for energy mix, including enhancement of supply and demand for alternative energy resources such as renewable energy. Section 19 (1)(s) of this Act makes provisions for the Minister to make regulations regarding the safe, healthy and sustainable use of energy, standards and specifications, not elsewhere legislated or regulated, for:

- the composition, colouring, labelling and form of energy carriers;
- low-smoke fuels; and
- the prohibition of the sale or combustion of polluting fuels.

5.6.3. Measures discouraging alternative fuels

Although there are measures that encourage the use of alternative fuels discussed above, a few examples of contradictory measures can be noted. These are summarised below.

5.6.3.1. Over-subsidisation of the conventional fuel industry

Similar to the over-subsidisation of conventional vehicles above, the production of liquid fuels in South Africa has historically enjoyed various government subsidies. Examples include the 1970s state oil security strategy which built local refineries and the synthetic fuels programme (Lott, 2016). In 2000, when the United Nations lifted sanctions against South Africa, the subsidy to synthetic fuels was successfully phased out. There was also the In-bond Landed Costs (IBLC) which has been replaced by the Basic Fuels Price (BFP) as well as the Rationalisation Plan (Ratplan), both of which have been replaced by the 2005 Petroleum Product Amendment Act (Lott, 2016). Despite the major political change represented by South Africa’s transition to democracy, Lott (2016) argued that the liquid fuels subsidy regime and state support to the liquid fuels industry in South Africa, have continued. The Tenth Schedule grants a 200% super deduction of capital expenditure in respect of exploration. There is also 150% super deduction of capital expenditure with respect to production benefits. These super deductions act as tax incentives to companies to invest in oil and gas exploration and production in South Africa, and as such, they effectively reduce the cost of producing oil and gas below that which would prevail under standard tax treatment. It is therefore argued in this section that this discourages the alternative path arising out of the continued incentives offered to the liquid fuels producers. The super deduction reduces the amount of government revenue collected and therefore amounts to a subsidy to oil and gas companies (Deloitte, 2016 and Lott, 2018)

5.6.3.2. Promising but slow legislative framework to incentivise use of bio derived fuels

Biomass derived fuels in South Africa are currently being generated and utilised, however at a very small scale (Stafford, Lotter, von Maltitz and Brent, 2018). Part of the reason for this could be related to the still ongoing processes at policy making levels to develop the pricing and incentive mechanisms for this fuel. Since 2007, much progress has been made to make provisions for biofuel production and utilisation in this country. The Regulations

Regarding Petroleum Products Specifications and Standards (Gazette No. 28958 of 23 June 2006) made provisions for blending of standard and low sulphur diesel grades of up to 5% v/v, 10%v/v, 20%v/v, 30% v/v and 50% v/v. Biodiesel B100, which must be 100% v/v biodiesel is also permitted in these standards. Regarding the sale and use of bio-derived petrol such as bioethanol, the specification does mention of requirements for this.

The breakthrough seems to have been in the development of the Regulations Regarding the Mandatory Blending of Biofuels with fossil-based petrol and diesel, which were promulgated by the Minister of the national Department of Energy in the Government Gazette (Gazette No. 31575 of August 2012). This process had however commenced in 2007, where the first work focused on developing a Biofuel Strategy for the country. The strategy set the scene for biofuels industry development in South Africa. Cabinet had approved an earlier version of this strategy in 2006 for further consultation with members of the public. The blending regulations then built from this strategy, where the main goal was to control blending of green liquid fuels with fossil-based fuels for commercial purposes. It stipulates minimum blending requirements of 5% v/v for biodiesel and 2% v/v up to 10% v/v for bioethanol.

Unlike the previous 2006 Regulations Regarding Petroleum Products Specifications and Standards, the 2012 regulations do not seem to say anything about situations where fuel users wish to use 100% biofuels in their automobiles, as these might have implications for the associated incentive mechanism. Developed in terms of section 12 C (1) of the Petroleum Products Act (Act No. 120 of 1977), these regulations were brought into effect on 1 October 2015 as per determination in the gazette (Government Notice, R719 of 30 September 2013). As such, the regulations are now effective.

As noted in the Department of Energy (2014), with this policy development, industry started gearing itself up for the challenge. Many entities showing interest, were set up to start exploring the process of producing this fuel in South Africa. Eight manufacturing licences (four bioethanol and four biodiesel licenses) had, as of 2014, been granted to produce about 1262 million litres/annum. In its 2015/16-2017/18 iteration of the Industrial Policy Action Plan (IPAP), **the dti** (2015) noted that the announcement by the Department of Energy meant that sorghum and soybeans were feedstock of choice to produce these fuels. This new industry therefore had potential to create around 15 billion Rands per annum worth of biofuels industry as well as creation of over 15 000 to 18 000 agricultural jobs (Department of Trade and Industries, 2015). The inclusion of sugarcane as feedstock would also mean new opportunities in the sugar industry, which for many years, has relied on a single product stream (Department of Trade and Industry, 2015)

Nonetheless, much of the hype about biofuels seems to have faded. Since 2014, no plant has been constructed which, according to the Department of Energy, could be linked to the reality that investments in biofuel initiatives are not financially viable, especially in times where crude oil prices are comparatively lower (Department of Energy, 2014). As such, this Department proposed that a better regulatory environment be created that is more conducive for the production of biofuels. Through a consultative process with various stakeholders, including the finance Ministry, the Department of Energy started working on an appropriate Biofuels Pricing and incentive mechanism. Following approval by cabinet on 13 December 2019, this framework was promulgated in the Government Gazette (Gazette No. 43003 of February 2020). The regulatory framework makes the following provisions with respect to biofuel industry development in South Africa:

- Recognition of biofuels produced from first, second and third generation feedstock, however saying nothing about fourth generation feedstock (such as Algae metabolic engineering). Reference crops for bio-ethanol are sorghum for grains/starches; and sugar cane for non-starches. For biodiesel, the reference crop is only soya beans. Food crops, specifically maize, are still excluded from the feedstock protocol,
- The framework targets biofuel penetration of 4.5% volume per volume (v/v) to the national transport fuel pool. For example, if the national pool is 100 litres, about 4.5 litres should be from biofuels. This however does not make a distinction between biodiesel and bioethanol. Only 2% of this is expected to come from first generation biofuels technologies, and the rest from the second and third generation feedstock,
- It recognises a need to support not only manufacturers of biofuels, but also farmers who wish to grow feedstock such as sugarcane for biofuel production,
- It calls for two types of incentives: *Farmer support scheme* to encourage the plantation of first generation feedstock as well as the *fuel producer (manufacture) support scheme* including blenders. The former will be administered by the National Department of Agriculture, Land Reform and Rural Development, while the latter will be administered by the Department of Trade and Industry as well as the Department of Minerals and Energy. While the Department of Trade and Industry is expected to provide capital funding for the construction and commissioning of biofuel projects, the Department of Energy and Minerals will administer the fund from a fuel price regulatory point of view.
- The incentives will be funded from the fuel levy, which will range between 3.5 and 4.0 cents/ litre and will only target first generation biofuels (Gazette No. 43003 of February 2020).

At the time of writing this section, Government, through the Biofuels Task Team (BTT), was devising implementation measures, including the development of criteria to fund first generation producers of biofuels. It is argued in this section that while this framework seems to have good intentions, it is not without limitations. First, it has been very slow from its inception in 2007. Also, its exclusion of second and third generation biofuels to benefit from the incentive scheme it provides, limits growth of players in this space. As noted in Stafford et al. (2018), second and third generation biofuels (largely, used vegetable oil) even though small, exist in South Africa. It is therefore argued in this section that to help these small scale producers grow, they also require some form of financial support. Besides these limitations of this latest policy framework, biofuels currently attract other taxes such as the fuel levy as discussed in the next sub-section.

5.6.3.3. Fuel levy imposed on green fuel (biodiesel)

While other types of fuels such as compressed natural gas are not burdened by the fuel levy, biodiesel (still a green fuel) is subjected to this levy. The levy on biodiesel was 177c/litre on 1 April 2020, with the levy on *other* biodiesels in the same period, set at 363c/litre (SARS, 2020). This is the same amount imposed on conventional diesel according to the media statement by the Central Energy Fund (2020). The levy raises the cost of biodiesel at the pump, hence counterbalancing the positive effects of rebates, refunds and 50% exemption discussed in the previous sub-sections. The amount of rebate or refund is key. As was noted in a research that the Department of Trade and Industry conducted in 2016, treating biodiesel in a different way to bio-ethanol and gaseous transport fuels (natural and biogas) creates inequality in the marketplace of low carbon fuels (Department of Trade and Industry, 2016).

5.6.3.4. The Value Added Tax (VAT) imposed on green fuels

The Value-Added Tax Act zero-rates conventional petrol, diesel and biodiesel for VAT purposes. Instead, a variety of levies, including the Fuel Levy, apply to these fuels, as shown in the June 2020 media statement by the Central Energy Fund (2020). VAT does, however, apply to natural gas, biogas and electricity, hence giving them a price disadvantage when compared to conventional fuels. While this is offset (as discussed in the preceding sections) by the fact that these fuels pay no fuel levy and no road accident fund levy, the future is uncertain causing the industry to remain agitated, as noted in a study by the Department of Trade and Industry (2016). It is, however, argued in this sub-section that VAT is small compared to the fuel and road accident fund levies that players in the natural gas, electricity and biogas space, are currently not paying. Besides the imposition of taxes such as VAT, import duties are also imposed on green fuels as discussed in the following sub-section.

5.6.3.5. Import duty imposed on green fuels from Mercosur and General member states

While green fuels from the EU, SADC and EFTA member states enjoy zero rates when they land in South Africa, the situation is different for fuels imported from Mercosur and General member states. Duties on fuels imported from these countries are imposed at fixed cent/litre rates for petrol, diesel and biodiesel, and are aimed at raising revenue, reducing pollution and compensating for road accidents (National Treasury Budget Review, 2015). In the previous sections, nascent industries were described as justifying high tariffs to protect domestic automotive industries. In principle, common reasons governments use to justify the imposition of tariffs vary from the protection of local industry, retaliating on unconducive foreign trade policies and local job creation, to name a few (Investopedia, 2015).

As discussed in the preceding sections, the country's biofuel industry is still in its infancy, hence creating a case for the adoption of stringent protection measures. The general import duty is R1.83/litre, which also applies to biodiesel imported from Mercusor member states, of which Brazil is a member (SARS, 2020). In reality though, the issue is not about competition between these countries and South Africa, but rather competition between biofuels sourced from these countries, with conventional fossil fuels used in South Africa. The Department of Energy (2014) noted that biofuel development and use in South Africa makes sense only when the price of conventional fuels is at its highest point. Since the price of petroleum fuels fluctuates, when crude oil goes down, so will the price of conventional fuels, and hence it is difficult to justify the addition of biofuel to the mix. Also, the legislative framework, as discussed above, seems no longer high on the political agenda.

As described in sub-section 1.4.3, major biofuel dominant regions include North America, South America (Brazil) and the European Union. Theoretically, these regions can easily render South African producers of biofuels unable to compete when viewed purely from an economic and trade policy perspective. The justification for high tariffs does not hold when the industry is non-existent. This is even worse when the products have the potential to address an environmental challenge such as the emission of greenhouse gases and environmental pollution. In principle, a higher tariff (as noted by Radcliffe, 2017) automatically discourages people from buying a product. This forces the country to forgo the potential benefits of pollution abatement. On the other hand, heavy reliance on imported fuels, as noted in Department of Trade and Industry (2015), has the potential to negatively affect the country's balance of payment account, jobs and GDP. It is argued here that this interplay between the environment and socio-economic pillars challenges policy and decision makers' ability to play a balancing act in the context of both the socio-economic and environmental pillars being of national importance to the South African Government.

5.6.3.6. Gas not yet declared as an energy source for vehicles

Gas as a fuel to promote sustainable transportation is currently unregulated under the Gas Act (Act No. 48 of 2001). This position by Government could be viewed in both a positive and negative light from the policy and investment points of view. By virtue of the gas being unregulated, gas is cheaper as no levies are imposed, hence driving initiatives such as the compressed natural gas powered municipal green transport buses and minibus-taxi conversions discussed in Chapter One. The disadvantage relates to the regulatory uncertainty that this creates, especially as gas is not explicitly declared a transport fuel. The

Gas Regulator Levies Act (Act No. 75 of 2002) was designed to give powers to the National Gas Regulator to impose, vary and/or set interest on levies.

Besides the regulatory uncertainly around gas taxation, another uncertainty relates to the sustainability of gas supply. While a treaty signed in 2001 by three institutions (Department of Minerals and Energy, Department of Trade and Industry as well as Sasol) provides some kind of security of supply relief, as indicated in the Gas Treaty (2001), this deal depends on many factors, including continued availability of gas in Mozambique. It is argued here that this is also dependent on the nature of political relationship between the governments of South Africa and Mozambique, over time. A review of provisions in the Gas Amendment Bill (2013) issued by the Department of Energy, reveals the following with respect to the Bill's intentions:

> To amend the Gas Act, 2001, so as to provide for the promotion of the orderly development of the gas industry; to enhance the national regulatory framework; to provide for socio-economic and environmentally sustainable development; to provide for new developments and changing technologies in the gas sector; to facilitate gas infrastructure development and investment; to provide for cooperation between the private and public sectors; to strengthen enforcement and improve compliance; and to provide for matters connected therewith (Department of Energy, 2013:2).

The definition of 'gas' in the Bill is now no longer restricted to gas "transported by pipeline" as was the case with the original definition. This means gas now refers to all types of hydrocarbon gases irrespective of transportation mode (Department of Energy, 2013), In essence, this now accommodates compressed natural gases transported by trailers to distant customers as is done by companies like CNG Holdings in South Africa (CNG Holdings, 2015). In essence, this also accommodates gases generated from landfill sites. This new definition enables reaching out to customers that are located far away from Sasol gas pipelines, including customers in provinces like Northwest, Free State, Eastern Cape, etc. The Bill demonstrates deviation or improvement from the original Gas Act of 2001 introduced above, whose focus was limited to the piped gas industry as indicated in the Government Gazette (Gazette No.23150 of 2001).

In this latest version of the gas legislation, there is however still no clause which explicitly declares that the transport industry can indeed use gas as fuel. Similar to other taxes not imposed on the gas, this omission has surely left the industry agitated.

5.7. POLICY PROVISIONS RELATING TO MODAL SHIFT

The buzz words dominating modal shift in South Africa include change from passenger car use to the use of public transport and a shift from road to rail. It could also mean a shift from conventional to alternative green transportation such as walking and cycling as depicted in the green transportation pyramid by Urban Hub (2020) in Chapter Two. This section examines policy provisions that make reference to modal shift as a transport greening option in South Africa. The two most relevant legislative documents, with provisions that address a modal shift from a greening perspective, are the National Land Transport Act (Act No.5 of 2009) and the National Road Traffic Act (Act No. 93 of 1996). Others such as the Roads Accident Fund Act (Act No. 56 of 1996 and amendments) and the National Railway Safety Regulator Act (Act No. 16 of 2002), are discussed merely for their implications on transport greening. They, however, do not provide specific provisions that relate directly to modal shift and which can be linked to the green transportation agenda. All these frameworks are relatively older, and as such, this research has other most recent policy documents, that contain provisions for modal shift. This is the Draft Roads Policy for South Africa (2017), the National Climate Change Response White Paper of 2011, the Infrastructure Development Act (Act No. 23 of 2014), the National Transport Master Plan (NATMAP2050) of 2016 and the National Framework on Sustainable Development (NSSD 1, 2009–2014) of 2011. Each of these legislative documents, in terms of their relevance to modal shift, are discussed in the following sub-sections.

5.7.1. The National Land Transport Act, 2009 (Act No. 05 of 2009)

This piece of legislation introduces a number of transportation concepts and modes, which can be linked to the green transportation pyramid and the 'avoid, shift and improve' (A-S-I) model introduced in Chapter Two. It provides definitions, which as they feature in the Act, have implications for transport sector greening. However, the Act does not say much about the greenness of these transport services and does not seem to prescribe the type of technology and fuel that these modes should use. Definitions provided relate to the following terminologies often used in a public transportation context:

> …bus**,** tuk-tuk**,** lift club**,** metered taxi service, midibus**,** minibus**,** minibus taxi-type service**,** adapted light delivery vehicle**,** infrastructure, integrated public transport network**,** integrated transport plan, public transport service, rail service (The Presidency, 2009: 8-16).

These are very important terms defined in this Act, as they give a sense of South Africa's understanding of various modes of public mobility in the country's transportation mix. Even though the Act does not prescribe the type of technology or fuel that these transport modes should adopt, it forms a key basis for further discussion on greening matters. The modes of transport prevalent in South Africa, linked to the definitions above, include municipal buses, the fleets provided by private bus operators, Metrorail, Gautrain, minibus-taxis, the Bus Rapid Transit system, Uber, metered taxis, car sharing, private vehicles, etc. In the study on modal shift in South Africa conducted by CSIR in 2013, Venter, Mokonyama, Letebele, Dube and Masondo (2013) noted that the choice of transport mode was strongly determined by the socio-economic status and perceptions as well as proximity of the chosen mode to the users.

The National Land Transport Act identifies and apportions land transport functions to national, provincial and local governments. It also makes provisions regarding the management of conflict between national and provincial legislation. As such, it shares close resemblance with section 146 (2) of the country's constitution. Section 5 (4) (g) (v) of this Act further refers to the Minister's responsibility to ensure adherence to energy efficiency principles, while also reducing the negative environmental effects of any measures taken in the management of land transportation. This is a very important provision, which, although the Act does not dictate regarding fuel and technology, assists in placing green thinking on the Government agenda.

Section 9 of this Act also highlights the functions of the Provincial Members of Executive Committees (MECs). They are required to ensure that there is correlation of such functions with matters that have an impact on transportation. Such matters include those issues, which relate to environmental management and infrastructure roll-out for efficient transportation. Again, this provision requires provincial legislators and / or decision makers to consider eco-mobility seriously in their decision-making processes. It can be argued therefore that sustainability thinking is well encouraged within sections 5 and 9 of this Act. The functions of the Minister and that of the MEC, can be described best within the context of promoting the three pillars of sustainable development. To reduce replication of efforts, Section 4 (e) of the National Land Transport Act further requires that the Minister of Transport should play a coordinating role between the functions of the three spheres of government. This provision hence places this legislative framework at the centre of land transport attempts to encourage the integrated approach, embedded within the systems approach to thinking. As such, the Act places itself very close to the provisions that deal with interdepartmental coordination in Chapter 3 of South Africa's Constitution.

5.7.2. Draft White Paper on Roads Policy for South Africa

In 2018, the National Department of Transport (DoT) gazetted the Draft White Paper on Roads Policy for South Africa (Gazette No. 41479 of 2 March 2018). This was gazetted for input, with a due date of 2 April 2018. It contains transport greening provisions, and hence is an improvement on the earlier versions of transport legislative frameworks such as the Land Transport Act of 2009 already discussed above. The policy is however biased towards the first three top legs of green transportation as shown in Chapter Three, as it places more emphasis on walking, cycling and use of public transport. Nonetheless, it makes provisions for the promotion of alternative fuels and cleaner vehicles (topics already covered in the previous sections of this chapter). These additional provisions were indeed missing from the less prescriptive earlier versions of land transport legislation. The vision for this Policy is however still informed by the vision of the DoT, which views transport as a centre of this country's socio-economic development. This vision does not seem to be balanced in terms of sustainable development thinking. It lacks the environment pillar. This makes sense to a certain extent since environmental protection falls specifically within the mandate of another department, the National Department of Environmental Affairs. Nonetheless, this policy set out national Government's strategic position on matters pertaining to road regulation, infrastructure, Non-Motorised Transport (NMT), safety and funding. It therefore integrates NMT as a recognised mode of transport.

Contrary to DoT's vision, the Draft White Paper on Roads Policy makes a strong case for sustainability, emphasising the importance of all pillars – economic, social and environmental goals of South Africa. It adopts a holistic approach acknowledging sustainability as an underlying and integral principle within transport management. The policy works closely with the National Planning Commission (2012), which set this country's national development goals to 2030. The Draft White Paper on Roads Policy places emphasis on road infrastructure as a key driver of economic development, talking about accessibility and affordability of roads to all users. It emphasises integration across the spheres of government. It talks about a need to protect 'green systems', referring to a variety of previous documents that promote transport greening including:

- National Framework on Sustainable Development,
- Intended Nationally Determined Contribution Discussion document, which sets the country's target for GHG reduction,
- Green Economy Modelling Report,
- White Paper on Energy Policy,
- Energy Efficiency Strategy, and IPAP's call for GHG mitigation options as the Public Transport Action Plan.

Policy statement number 44 of the Draft White Paper on Roads Policy for South Africa, requires all planning authorities to establish a strategy and regulatory framework that will promote Non-Motorised Transport usage. Areas of this policy that show strong linkages with green transportation include the following:

- With the transport sector's current contribution to GHG and air pollution, the policy emphasises a need to shift the role of roads from serving predominantly private vehicles which are road based towards more integrated systems incorporating walking, bicycling, public transport and use of rail and sea transportation systems. This will address issues of air quality, energy consumption and traffic congestion, among others.
- The policy also emphasises a need for South Africa to transition towards development of local industry and conversion of raw transport related materials into finished products and localisation of skills.
- It talks about the need to promote economic growth and employment goals, citing opportunities during the construction and maintenance of roads, during the manufacturing of vehicles. It also talks about a need to explore new business opportunities in greener energy sources for use in non-public automobiles.

- Policy statement 15 commits to developing a comprehensive set of minimum 'green' road norms and standards embedded within sustainability principles to be applied throughout the road network value chain. They will apply to new and upgraded roads. There will be a self-assessment or an independent certification process for road builders.
- Policy statement 56: Working together with other departments, industry and civil society, DoT will implement programmes aimed at reducing greenhouse gas emissions by promoting the use of public transport, NMT and eco-mobility technologies such as battery powered vehicles and cycles. Here it talks about establishing an incentive scheme that will encourage students and scholars to conduct research on the role of NMT in climate change. It also talks about a need to raise awareness. Activities here that require support go beyond pure awareness raising and research. There is a need to roll out infrastructure to support the adoption of alternative fuels, electric vehicles charging points and CNG refuelling points along major transport routes, e.g. Pretoria to Johannesburg.
- Policy statement 57: Introduces environmental sustainable practices into NMT facility and infrastructure design.
- Policy statement 60: DoT and NT will explore the full range of financial mechanisms available to enable increased funding (Gazette No.41479 of 2 March 2018).

5.7.3. The National Road Traffic Act (Act No. 93 of 1996).

Chapter 4 of this legislative framework makes provisions for transport planning, including the development of integrated transport plans, which must form part of Integrated Development Plan (IDP) formulation process at municipal level. Provincial government approves these plans in accordance with period prescribed by the National Minister of the Department of Transport. So this Act provides a clear relationship between the three spheres of governance when it comes to transport planning. While there is no evidence of prescription in terms of transportation modes or technologies that municipalities should include in these plans, section 36(4) (e) of the Act requires that the integrated transport plans be limited to those areas under the mandate of a provincial authority. Indeed, the City of Tshwane, the City of Johannesburg, the City of Cape Town and the City of Durban have gone ahead procuring green buses, the BRT, etc. Here linkages are evident with the A-S-I model and the green transportation pyramid depicted in Chapter Two by Urban Hub (2020) and GIZ (2016). As a transport planning issue, it should be noted, however, that this was beyond the scope of this research. It is a research gap noted and highlighted in Chapters Four and Eight, and which requires further research in the future. Nonetheless, some critics noted that while South Africa's cities are by law, all obliged to develop transport related plans, those who prepare them, only do it for compliance purposes. They are hence deemed not to feature strongly in the Integrated Development Plans (IDPs) in terms of implementation. Integrated transport planning according to these critics, therefore, is an ongoing process to ensure that all modes are treated equally and that all segments within the freight and passenger transport subsectors are adequately provided with an effective transport system.

5.7.4. The Infrastructure Development Act (Act No. 23 of 2014)

Based on the principles in the Government adopted National Infrastructure Plan of 2012, the country's cabinet set up a commission called the Presidential Infrastructure Coordinating Commission (PICC) (Government Communication and Information System, 2020). With the commission's secretariat work under the National Minister in the Department of Economic Development, it had the huge task of coordinating and facilitating speedy implementation of infrastructure projects. Work of this commission was surely strengthened by later promulgation of the Infrastructure Development Act (Act No. 23 of 2014), which clarifies functions of the PICC. When this Commission was established, a needs assessment proposed 18 projects spread across the Electricity, Water, Transport, Town planning and Ports areas. In its Minister's 2017/2018 Budget vote, the Department of Economic Development (2017) noted that Government and the private sector have since 2013 invested over R300 billion in the infrastructure plan. These investments cover social, economic and environmental aspects. The government contribution emanates from three main sources of income which include taxes, property and loans. Income from tax, according to Mohr et al. (2015), is the largest contributor to South Africa's government source, which in 2013 accounted for 97.8% of total budget revenue. The allocation and spending of these funds in various programmes of Government is done according to the prescripts in Chapter 13 of the Constitution, with spending further governed by other legislative frameworks regulating the management of finances at the three spheres of governance. These include the Public Finance Management Act, Treasury Regulations and the Municipal Systems Act (Act No. 32 of 2000), etc. The PICC created a case for a transport sector related Strategic Infrastructure Programme (SIP7). This programme deals specifically with the Integrated Urban Space and Public Transport Programme. On the transport side, it deals specifically with the integrated public transportation network such as commuter rail, taxis, buses, BRT, integrated ticketing and intelligent transport systems. These are purely modal shift related priorities, with less discussion on their 'greenness' (e.g. how much renewable energy are they going to use, etc.). Linked to this is SIP 6: Integrated municipal infrastructure project, which also makes provisions for road maintenance to enhance service delivery (Department of Economic Development, 2017). Again, the emphasis here is not on non-motorised transport, but rather on the availability of roads to cater for traditional transportation systems. As noted in the budget review by National Treasury (2019), both SIP7 and SIP6 in the period 2015 to 2018 have been allocated larger budgets from the fiscus, compared to their SIP counterparts. This gives some indication of Government's commitment to supporting public transport infrastructure provision. Another programme of relevance in this discussion is SIP8: Green energy in support of the South

African economy. While this programme has also been allocated some funds from the fiscus, it has however received one of the lowest allocations compared to other SIPs in the period 2015 to 2018 as shown in Table 5.8.

Table 5.8. Allocation from the fiscus to SIPs (National Treasury, 2019)

R million SIP category	2015/16	2016/17 Audited outcome	2017/18	2018/19 Preliminary outcome	2019/20	2020/21 Forecast	2021/22
SIP 1: Unlocking the northern mineral belt with Waterberg as catalyst	393	819	291	580	914	1 158	1 115
SIP 2: Durban, Free-State, Gauteng logistics and industrial corridor	188	217	128	110	110	35	–
SIP 3: South eastern node and corridor development	8 927	9 356	11 122	7 022	15 082	14 297	13 753
SIP 4: Unlocking economic opportunities in the North West province	881	496	429	363	325	419	495
SIP 5: Saldanha-Northern Cape development corridor	196	–	5	–	268	378	427
SIP 6: Integrated municipal infrastructure project	22 426	20 937	21 644	22 001	20 226	20 704	22 298
SIP 7: Integrated urban space and public transport programme	49 075	49 749	47 679	44 932	49 741	51 564	57 355
SIP 8: Green energy in support of the South African economy	129	137	501	147	159	167	180

Table 5.8 does not show all SIPs, which are 18 in total, as mentioned earlier in the preceding paragraph. Government exercises extreme caution on where to channel the revenue collected, with most pressing needs likely to receive priority. These are likely to be the priorities that yield political scores in the form of more votes during election times. In the review of government budgetary processes in America, Oyakojo (2015) revealed various literature views on the purpose of budgeting. He discussed perspectives of politicians, public administrators, accountants and economists, concluding that the budgetary process and system is more political than technical. In the case of South Africa, the infrastructure projects facilitated under SIP7 above may thus leave a legacy which, if implemented successfully and highlighted during election campaigns, may appeal to voters. Also, the infrastructure-related projects present something tangible and more importantly, something that addresses legacy issues from apartheid-linked spatial planning. As noted in National Treasury (2019), total expenditure on transport and logistics in the period 2015-2018 has been the highest compared to spending on other services such as health, energy, education and others. In 2017/ 2018, expenditure on transport and logistics reached about R75.4billion compared to its closest counterpart, energy, at R55.1 billion and its furthest counterparts – health and administration services at R9.7billion and R9.1billion, respectively (National

Treasury, 2019). This included provision of infrastructure services such as the integrated public transport network, the railway infrastructure including network upgrade, train upgrade and purchase of new trains, among others.

While the discussion above highlights Government's commitment to roll out infrastructure targeted at supporting public transport, the emergence of new transportation technologies require more (or streamlining of) resources to cater for these new technologies. More funding targeting charging infrastructure for alternative energy vehicles such as EVs, Natural Gas Vehicles (NGVs) and production of biofuels and associated infrastructure, is still required. Nonetheless, the Infrastructure Development Act (Act No. 23 of 2014) and the National Infrastructure Plan of 2012 have provided and can still be used to facilitate infrastructure roll-out for these new automobile technologies, hence achieving more in terms of reducing tail pipe emissions from public transportation systems. South Africa's attempts to reduce tail pipe emissions such as CO_2 are also addressed through the use of policy frameworks such as the National Climate Change Response White Paper, discussed in the following sub-section.

5.7.5. The National Climate Change Response White Paper

To present the South African Government's vision for an effective climate change response and the long-term, just transition to a climate-resilient and lower-carbon economy and society, in 2011 South Africa developed the National Climate Change Response White Paper (Department of Environmental Affairs, 2011), often referred to as the NCCRWP. It provides a set of programmes, which South Africa needed to prioritise as a way of achieving specific short-term, medium-term and long-term goals related to climate change mitigation and adaptation. As noted in the Department of Transport (2018) and in the International Energy Agency (2014), GHG emissions from South Africa's transport sector accounted for about 10.8% and 11% of the country's total GHG emissions in 2012. The Department of Environmental Affairs (2018) recorded this figure at 9.2%, depicting the transport sector as the third largest contributor of GHG emissions, after the industry sector at 12.8% and the energy sector at 67.8%. Due to the use of vehicles powered by fossil-based diesel and petrol, the road transport segment, has been responsible for almost 91.2% of these GHG emissions (WWF, 2016). In the context of discussion in this sub-section, the NCCRWP makes provisions for the implementation of a transport flagship programme. This places the National Department of Transport at the centre of programme implementation, with the specific role of facilitating the development of cleaner transportation programmes in South Africa's specific metropolitan areas. As already alluded to in Section 5.2, this programme was expected to embark on interventions that would result in measurable improvements in vehicle efficiency, including the roll-out of measures to improve the efficiency of the Government fleet by 2020 (Department of Environmental Affairs, 2011). The flagship programme, according to Motsepe (2017), involved efforts to make available and accessible the integrated transport systems, prioritising the use of more efficient spatial design, transport networks and operations; low emissions transport modes, vehicles, fuels, technology; non-motorised transport; and climate-resilient infrastructure. This also included a need to roll out the rail re-capitalisation programme to facilitate modal shifts of both the passenger and freight transports from road to rail. It encouraged the adoption of new efficient-vehicle technologies, such as electric vehicles, stating that Government will set procurement objectives for acquiring such vehicles (Department of Environmental Affairs, 2011).

The NCCRWP use of such concepts as modal shift, non-motorised transport, efficient spatial design, low emissions transport modes, efficient-vehicle technologies, alluded to in Motsepe (2017) and Department of Environmental Affairs (2011), have relevance to the Avoid-Shift-Improve model from GIZ (2016) in Chapter Two. It reflects sustainable transportation ideologies which, it is argued here, open up opportunities for South Africa to transition further up in the green transportation pyramid towards eco-friendly forms of commuting as depicted in Figure 2.1 adapted from Urban Hub (2020). In the context of this policy framework, however, the driver is climate change. As such, the globalisation theories introduced in Robinson (2007), Wu (2016) and Hurst (2018), become relevant. Perhaps the best explanation of South Africa's embankment on climate change response measures, is that provided in Major (2013), who described globalisation in the context of three processes termed competition, emulation, and coercion. Indeed South Africa committed to the global community that it would reduce its share of contribution to GHG emissions. It did this by first ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in 1997 and the Kyoto Protocol in 2002 (Department of Environmental Affairs, 2018). Later in 2009, this country made further commitments in the Copenhagen Accord, to reduce its GHG emissions by 34% in 2020 and by 42% in 2025, below the business as usual. This was however dependent on the extent to which core countries meet their commitments to provide needed resources (financial, capacity-building, technology development and technology transfer) to the semi-periphery (Department of Environmental Affairs, 2018). Further to these earlier commitments, South Africa signed the Paris Agreement in 2015, which sets the similar goal of limiting global average temperature increase above pre-industrial levels to well below 2°C, and to pursue strong efforts to limit the increase to 1.5°C. Here, South Africa's commitment to GHG reductions is in phase form, peaking from 2020-2025, levelling from 2026 -2035 and declining from 2036 onwards.

What drove South Africa to commit so much could be related to the extent to which this country contributes to the climate change problem. In its global ranking of countries' per capita CO_2 emissions, the Union of Concerned Scientists (2020) ranked South Africa tenth in 2017, with the per capita CO_2 emission of 7.4 metric tons (MT). It shared the top ten list with Poland (8.1MT), Germany (8.7MT), Japan (8.9MT), Russia (10.6MT), South Korea

(11.7MT), USA (14.6MT), Canada (14.9MT), Australia (15.6MT) and Saudi Arabia at 16.1MT (Union of Concerned Scientists, 2020). These figures show up these countries, including South Africa, as real culprits in the climate change problem. Hence, with the transport sector being the third largest contributor to South Africa's GHG problem, the transport flagship measures presented in the National Climate Change Response White Paper, seem important for reducing GHG emissions. Modal shift implies a form of strategy to promote eco-mobility. The discussion on this is covered in various policy documents, including the National Framework on Sustainable Development covered in the next sub-section.

5.7.6. The National Framework on Sustainable Development

Approved by Cabinet in 2011, South Africa's National Strategy for Sustainable Development and Action Plan, also known as the NSSD 1 (2009–2014) builds on the National Framework on Sustainable Development (NFSD) approved by Cabinet in 2008 (Department of Environmental Affairs, 2011). These documents are crucial in debates around transport greening. The NSSD 1 acknowledges how the current structure of society in South Africa often prevents people from behaving in a sustainable manner, even when they would like to do so, and highlights this argument by referring to the lack of safe and efficient public transportation systems. To improve the situation, the NSSD identified specific projects for implementation in the transport sector. In priority number 3 (green economy), this strategy devised an implementation programme seeking to encourage a just transition towards a resource-efficient, low-carbon and pro-employment growth path. It recommends the introduction of infrastructure and sustainable transportation measures to reduce the transport sector's carbon footprint through cost-effective interventions. These interventions include shifting freight from road to rail, as well as passengers towards public and non-motorised transport. The measures also include shifting from inefficient and internal combustion engine vehicles to efficient, hybrid and electric vehicles. Priority number 5 of this strategy is a direct response to climate change and city-wide emissions resulting from this country's reliance on private automobiles. The action plan prioritises city-wide roll-out of public transport systems by 2020.

The initiatives and recommendations in this sustainable development policy of South Africa, relate to other policy documents in their recognition of the inefficient nature of this country's transportation systems. Another policy document which highlights this problem and recommends modal shift measures comparable to those identified in the NSSD 1, is the National Transport Masterplan, discussed in the following sub-section.

5.7.7. The National Transport Masterplan

The National Transport Masterplan (NATMAP, 2050) is a cornerstone document that outlines the Department of Transport's plans up to 2050. Commissioned in 2005, developed from 2007 and completed in 2010/11, this plan was approved by cabinet in October 2016 following a protracted consultation process with various stakeholders (Morapedi and Makhari, 2017). NATMAP covers various themes in transport planning, which are presented in chapter format. It provides a framework for multimodal transportation system, with the aim of achieving the following aspects:

> An integrated, smart and efficient transport system supporting a thriving economy that promotes sustainable economic growth, supports a healthier lifestyle, provides safe and accessible mobility options, socially includes all communities and preserves the environment (Morapedi and Makhari, 2017).

The key themes of NATMAP include energy and environment; infrastructure planning; emerging transport realities in the science, innovation and technology space; passenger transport; freight transport; integrated transport planning; and land use planning (Department of Transport, 2016). These themes are all important in the context of modal shift, with Chapters 9 and 8 addressing energy, environment and public transport, discussed in this section. Chapter 9 on energy and environment recognises the interlinkages between transport, energy and environment, including the transport sector contribution to 34% energy use in South Africa. As such, it calls for an integrated approach to transport decision-making processes that incorporates these three sectors. The relevance of this chapter in the context of modal shift relates to its recognition of various modes' contribution to greenhouse gas emissions. It recognises that reducing total energy demand and hence GHGs, requires behaviour shift from carbon intensive and energy consuming transport modes to modes that use less energy and generate less carbon dioxide emissions. While it recognises that the energy intensity of all modes of transport has improved worldwide, the associated increase in transport use counterbalances efficiency gains. To improve the situation, NATMAP proposes short, medium and long term interventions, which appear to be aligned with the Avoid-Shift- Improve model introduced by GIZ (2016) in Chapter Two of this thesis. In the short term (1-3 years), NATMAP proposes the introduction of awareness raising campaigns, promoting Non-motorised Transport (NMT), fuel efficiency measures, plans for new long-distance transportation infrastructure, with lower energy intensity compared to road transport and implementation of existing transport plans such as the Nationally Determined Contributions (NDCs) as agreed at COP 21. It proposes a medium term plan (i.e. 3 to 7 years) to continue implementing short term measures, the Green Transport Strategy, the Transport Flagship Programme of the National Climate Change Reduction White Paper (2011), and to implement the nationally appropriate mitigation measures (NAMAs). In the context of this sub-section, the relevant NAMAs mentioned include modal shift from cars to public transport as well as modal shift from road transport to freight rail. The long-term measures (i.e. 7-10 years) involve the review of medium-term measures, the implementation of long-distance transportation infrastructure as well as the expansion of the quantity of goods and number of people affected by transport mode shifts, among others (Department of Transport, 2016).

Chapter 8 of the NATMAP discusses the status quo of South Africa's public transport system, alluding to the need for this country to develop a modal shift strategy that addresses widespread dissatisfaction with passenger transport services. It recognises South Africa's exponential growth in private car ownership, which occurred without much improvement in the passenger transportation system. It acknowledges that the passenger transport system is broadly inefficient, not customer-focused and has poor levels of reliability, predictability, comfort and safety (Department of Transport, 2016). The exception, according to this Department, is the Gautrain and the newly implemented bus rapid transit (BRT) systems in selected metropolitan municipalities. To improve the situation and enhance modal shift, NATPLAN recommends the follow among others:

- The development of an overarching public transport subsidy policy that incorporates all modes of public transport to subsidise users and not the operators.
- Appropriate modal technology choice guidance must be developed to ensure that alternatives are appropriately assessed and that demand-driven and -responsive services are implemented.
- An in-depth evaluation of the existing BRT delivery model, identifying ways this could be improved.
- Development of public transport planning guidelines, to address the alignment of spatial and geographical development, population densities and land use patterns with appropriate modal and infrastructure responses based on technology choice analysis.
- The provision of NMT is underlined by its associated policy, addressed by the national rural strategy as well as the IRPTN requirements for NMT facilities around BRT facilities. However, a comprehensive NMT strategy and guideline document is required for the overall urban and rural transport system (Department of Transport, 2016: 8-22).

With these provisions in NATMAP, South Africa, according to Schoeman (2013), had made huge progress over the past 18 years in transforming its transportation policies and legislative frameworks. With this progress having culminated in the completion of the NATMAP (2050) project, the next step then is implementation of this project including ensuring integration and alignment on national level to implement, ongoing assessment and managing growth and development (Schoeman, 2013). As a project that involves many stakeholders, Morapedi and Makhari (2017) advise careful attention in implementing the interventions and projects defined in the NATMAP. Since this project is not funded from a central point, it has implications for vertical and horizontal integration, including collaboration between organs of state at all levels (Morapedi and Makhari, 2017). For its recognition of various modes of transportation, NATMAP, as discussed in this sub-section has implications for Non-Motorised Transport (NMT). Other policy frameworks that have implications for NMT are discussed in the following section.

5.8. POLICY PROVISIONS RELATING TO NON-MOTORISED TRANSPORT

The concept of non-motorised transportation (NMT) features prominently in green sustainable transportation literature. In Chapter Two, it forms part of the pyramid model depicted in Urban Hub (2020), where NMT is denoted as one of the environmentally friendly modes of commuting. It is one of the transport modes which Lejda et al. (2017) argued, are being promoted by authorities in the European Cities. While the emphasis in the Urban Hub pyramid seems to be limiting NMT to the use of utility bicycles, cycling and walking/ running, the list in expanded in South Africa to incorporate other parameters.

Defined in the introduction section of South Africa's Non-Motorised Transport Policy of 2008, NMT includes all means of transport that are human powered. This includes walking, animal-power, bicycling and many other variants such as skates, skateboards, push scooters, hand carts and wheelchair travel (Department of Transport, 2008). This policy recognises that most transport in South Africa takes place by road, ranging from walking on unpaved paths to motor transport on well-paved roads. For the majority of people in rural areas, however, walking usually remains as the only available option. While acknowledging that, for shorter trips, walking is the main mode of transport in most societies whether poor or rich, in South Africa, most transport travel is for essential trips rather than for leisure (Department of Transport, 2008).

The National Non-motorised Transport Policy of 2008, was the first policy document that was developed to stimulate thinking around the formalisation of NMT. It provides baseline information for this country to promote use of alternative transport modes, referring to it as one of the critical players in this country's transportation systems. As opposed to contributing to the modal shift debates discussed in the preceding section, however, the NMT policy sought to create an environment conducive for existing NMT users. The policy further elaborates (as summarised in Table 5.9) on the role of each sphere of governance.

Table 5.9: Share of NMT responsibilities among three spheres of government (by author)

Municipalities	Provincial Government	National Department of Transport
The municipal by-laws relating to the transportation sector should be amended to include provisions of this policy.	This sphere of governance is expected to provide some skills and knowledge to the municipalities, regarding the implementation of this policy.	Where needed, provide cycling lanes when upgrading or
To develop Integrated Transport Plans, which incorporate NMT.		

		developing new road networks.
Both local and provincial authorities to develop appropriate mechanisms to fund NMT.		
To facilitate capacity-building initiatives, equipping themselves with skills for effective implementation of NMT policy provisions relevant to them.		

It has been over ten years since this policy framework was first produced in 2008. Nonetheless, debates relating to NMT continue in Government policy discussions. As alluded to in the previous section, the country's NATMAP-2050 promotes NMT as an important short-term measure for South Africa. By short term, the department meant a three-year period from 2011 (which ended in 2014). Since 2014, this department further developed the Land Transport Amendment Bill of 2016. Published in the Government Gazette (Gazette No. 39798 of 2016), this Bill was designed to amend the National Land Transport Act (Act No. 5 of 2009). The Bill makes provisions for what seems like clear promotion of NMT and accessible transportation in line with international best practices. The definition for "Integrated Public Transport Network" in the 2009 Act is now amended in this Bill to include NMT.

The Bill inserts a new section (Section 10A) which forces the Minister of Transport and all provincial transport Members of Executive Committees (MECs) and local planning authorities to take steps in performing their functions under this Act to promote accessible transport and non-motorised transport. Another policy framework that seems to support NMT is the Draft Roads Policy for South Africa (2017). This policy recognises NMT, citing climate change and air quality drivers, with the following extracted from the Minister's foreword:

> The role of roads needs to shift away from serving predominantly private vehicles and road based freight toward more supporting integrated mobility systems centred on walking, cycling… In light of this, South Africa needs to ensure that its roads policies make best use of infrastructure budgets to further economic, social and environmental goals simultaneously (Department of Transport, 2017:2).

These sustained developments in the non-motorised transport legislative environment seem to signal the state's enthusiasm towards this 'green' mode of transportation. It is a mode which, as noted in the following paragraph, is already supported from an import point of view, through duty free or reduced duties on certain products entering the Republic of South Africa. Currently, there is no duty on non-motorised transport goods such as bicycles emanating from the European Union, SADC and EFTA member countries. The only existing duties are 15% and 11, 25%, respectively on bicycles imported from Mercosur and other parts of the world (including China, other Asian countries, America, Middle East). See Table

5.10 for tariffs on imported bicycles which the author reproduced from the South African Revenue Service (SARS) tariff book.

Table 5.10: Tariffs on imported bicycles (SARS Tariff Book, 2018)

Heading/ sub-heading	Description	RATE OF DUTY				
		General	EU	EFTA	SADC	MERCOSUR
8711.60	Bicycles that can also be propelled electrically	0	0	0	0	0
8712.00.10	Non-motorised bicycles	15%	0	0	0	11,25%
8712.00.90	Other cycles (including delivery tri-cycles), not motorised	0	0	0	0	0

At the NMT conference in 2014, while emphasising the critical role that bicycles play in societies, Wheeldon (2014) was mindful of the many fatal accidents involving bicycles. These occur partly due to lack of integrated planning, lack of awareness and negative attitudes towards bicycle users and a lack of cycling infrastructure. Mokitimi and Vanderschuren (2016) partly attributed non prioritisation of NMT to the 40% pedestrian fatalities recorded on South African roads. With about 64% of this country's learners using walking as a mode of commuting, especially in rural areas, these writers recommend that NMT planning should give these areas more priority. Wheeldon (2014) associated bicycling with all the sustainability pillars. The economic pillar is achieved through lower cost of mobility and jobs created. The environment and health pillars are associated with cleaner air, exercise and fewer wars. The social pillar relates to this mode's ability to bring people together as they make bicycling journeys together.

5.9. CONCLUSION

This chapter has examined various policy and legislative documents developed in the past and those that are still being developed in South Africa, describing the manner they address and /or fail to address aspects related to transport sector greening. Most of the analysis presented focused on the review of prescripts as they are captured in the legislative and policy documents. The chapter has provided a legislative review guided by six thematic areas borrowed from the literature: clean fuels, vehicle fuel economy, technology switch, fuel switch, modal shift and lastly, non-motorised transport. A summary of these findings is shown in Figure 5.7. Due to the multidisciplinary and cross-cutting nature of the green economy concept, of which transport greening is a subsidiary, the policy and legislative frameworks reviewed include those developed by various departments in Government. The major departments covered included National Treasury, Department of Energy, Department of Transport, Department of Environmental Affairs and Department of Trade and Industry. The frameworks developed by agencies of these departments were also reviewed. Specific agencies whose policies were reviewed included the South African Bureau of Standards, the South African Regulator of Compulsory Specifications, the South African Revenue Services and the Central Energy Fund, among others.

From the review of legislative and policy frameworks, it was noted that South Africa indeed has numerous policy and legislative frameworks that address transport sector greening. The primary mandate of the Department of Transport, as an example, is not transport greening, but rather the provision of transport systems, among others. The addition of transport greening provisions in its policy and legislative documents is driven by various factors including a desire to support its sister department: Environmental Affairs, through which South Africa has signed many international commitments targeting climate change. This, as well as other examples referring to South Africa's adoption of world thinking with respect to clean fuel, fuel economy standards, fuel and technology switch, demonstrate the power of technology and ideology diaspora characterising the globalisation story introduced in globalisation theories in Chapter Three. Most inventions and concepts in the transport greening arena seem to have originated from the developed world countries. With South Africa joining this bandwagon, the driver can be explained in many ways. On one hand, it could be natural evolution with South Africa having found itself forced to follow global leaders. On the other hand, it could be that this country is simply adopting diplomatic strategies or is attempting to be patriotic to the international community.

Whatever the case, it remains important to note that, in this country, the socio-economic and environmental problems associated with the traditional approaches to transportation are a reality. While global influence is noted, it is argued that it has played an important role in encouraging the South African Government to enforce its own commitments made in the Bill of Rights, Section 24 of the Constitution (Act No. 108 of 1996), which states the following:

> Everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (Government Gazette, 1996: 1251-1253).

With the use of various policy and legislative levers discussed in this chapter, South Africa seems to be attempting to demonstrate its commitments to upholding the principles contained in the Bill of Rights, by addressing the challenges associated with unsustainable forms of transportation. Figure 5.7 depicts the summary of what has been covered in this chapter, including various policy, regulatory and legislative frameworks designed to uphold these rights.

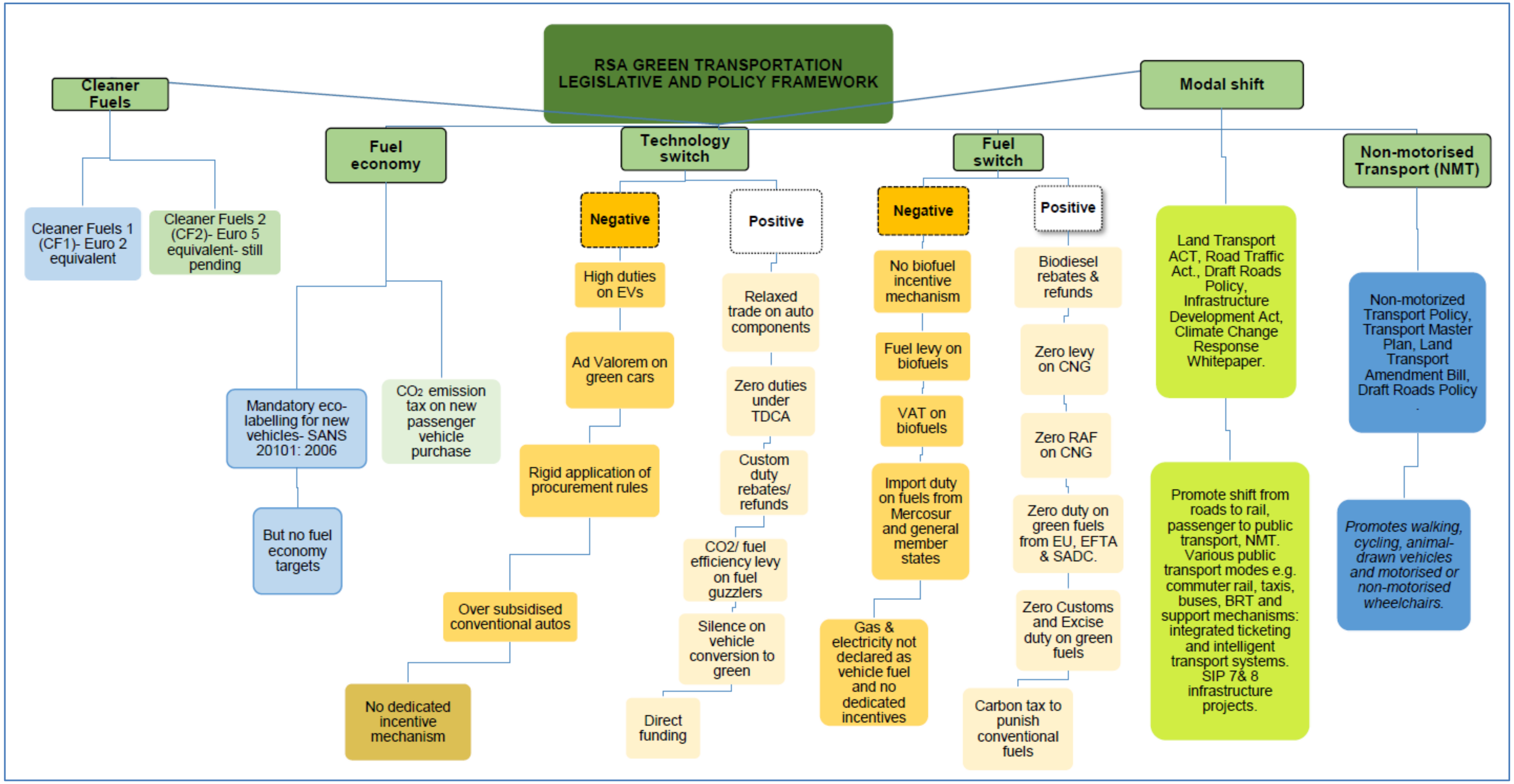

Figure 5.7: Summary of legislative review findings

What is happening in South Africa could also be explained using the various conceptual frameworks introduced in Chapter Three. There are strong elements that demonstrate policy commitments to the sustainable development principles, as they express aspirations of economic development, social upliftment as well as environmental protection. Efforts by various departments to pursue transport greening initiatives also demonstrate the interconnectedness of the government system congruent with a systems approach to thinking. They seem to do this in the spirit of coordinated efforts and working togetherness as entrenched in the country's Constitution which, as discussed in Chapter Three, seems to have been founded on a systems approach to thinking. While departments might have their own motives for pursuing transport greening initiatives, it must however be noted that by law, they are obliged to support the Department of Environmental Affairs work through the preparation of Environmental Management Plans (EMPs) or the Environmental Implementation Plans (EIPs). As such, the role of this department in promoting a transition towards a low carbon economy should not be underestimated. Ultimately, however, it is argued that this country should be able to reap maximum benefits from the process of greening its transport sector.

While the current chapter has critically reviewed the way policy, regulatory and legislative frameworks address transport sector greening in South Africa, the following chapter presents findings on how South Africans perceive these frameworks.

CHAPTER SIX

RESULTS ON TRANSPORT GREENING VIEWS IN SOUTH AFRICA

6.1. INTRODUCTION

Views on transport sector greening at an international level were presented in Chapter Two where issues around lack of harmony in defining green transportation were cited prominently as a major hindrance. The literature assigned various definitions to the concept of green transportation, with Zhou (2012) emphasising how inconsistent these definitions are and Nijkamp et al. (2001) also noting the ambiguous nature of these definitions. These ambiguities have created confusion in attempts to pursue a greening agenda. Various worldviews were also discussed around the concept of 'green economy' (an overarching umbrella to transport greening). These included ecocentrism, anthropocentrism, neoliberalism, free enterprise and interventionism/ Keynesianism – the interactions of these have created further dilemmas in greening efforts. Governments were hence perceived to be both enablers and constrainers of transport greening which, if defined in terms of drivers, means different things to the Europeans, North Americans, Latin Americans, Asia Pacificans and Africans. With governments viewed so ambiguously, interventionist theories are at the centre of conceptual frameworks to interpret views presented in this chapter. As per arguments in Zuidgeest et al. (2000), it was also revealed that most definitions assigned to transport greening tend to link this phrase to the broader sustainable development debates. With these debates calling for sustainability thinking to be at the forefront of transport greening agenda, sustainable development theories introduced in Chapter Three are equally relevant in this chapter.

While Chapter Five presented findings on the exercise conducted to review South Africa's policy, regulatory and legislative frameworks to transport sector greening, the current chapter supplements these findings, focusing now on the intangible phenomena (i.e. the views, opinions, insights and perceptions). These are views, opinions, insights and perceptions of key stakeholders in Government and private sector institutions regarding the current state of affairs in the country's green transportation regime. This chapter captures the participants' sentiments on the status quo as well as their beliefs regarding the best route for South Africa in a transition towards a greener transportation era. Informed by literature views presented in Chapter Two and the conceptual frameworks presented in Chapter Three, this chapter addresses the second objective of the research which sought to *explore views on the current regime relating to transport sector greening*.

The chapter presents views on the status quo and future options for transport greening in South Africa, the roles and performance of Government institutions, strengths and flaws as well as measures required to address system weaknesses. As indicated in Chapter Four, the profile of participants that were interviewed directly include Senior and Mid-management officials in the following Government departments, as well as senior representatives in select industry organisations:

- Department of Transport (DoT)
- Department of Science and Technology (DST)
- Department of Environmental Affairs (DEA)
- Department of Trade and Industry (**the dti**)
- Department of Finance (National Treasury) (NT)
- South African National Energy Development Institute (SANEDI)
- National Association of Automobile Manufacturers of South Africa (NAAMSA)
- United Nations Industry Development Organisation (UNIDO)
- Compressed Natural Gas (CNG Holdings)

Due to the research constraints explained in Chapter Four, views from representatives of other key institutions that could not be reached through the direct interviews, were collected from their official reports. These institutions had made presentations, highlighting their positions, views and concerns at the Competition Commission Market Inquiry into Land-based Public Passenger Transport Industry in 2018. The institutions were as follows:

- City of Cape Town Transport and Urban Development Authority
- City of Johannesburg
- Provincial Department of Transport and Public Works (Western Cape)
- Provincial Department of Transport (KwaZulu-Natal)
- eThekwini Transport Authority
- Provincial Department of Roads and Transport (Gauteng)
- South African National Taxi Council (both the national and KZN branches)

Views of individuals from various institutions were collected during the following events:

- Electric Vehicle Industry Alliance (EVIA) meetings and conferences
- Sustainability Week conference in 2018
- RoundTable on future mobility seminar in 2018
- Low carbon project steering committee meetings in 2017-2018
- Biogas conference and biogas platform, 2016
- International Council on Clean Transportation Vehicle Efficiency Research seminars, 2017

- ❒ Various sessions during the development of the Green Transport Strategy (GTS 2020-2040)
- ❒ Department of Trade and Industry– various meetings targeting green transport sector development.

Also official documents from the Department of Energy, SANEDI, uYilo Programme and the National Department of Transport were used. All views collected from the events and official documents referred to above, were used to supplement views collected from direct interviews. They were treated as interview respondents, a technique described in O'Leary (2014) as exploring the "witting" evidence (i.e. the actual content of the documents). They were treated like interview respondents based on a set of questions from the interview guide used to interview respondents directly. This involved asking the question, and then looking for answers in the documents as described in O'Leary (2014). The sentiments collected this way are discussed in eight major categories which this chapter presents chronologically from the smallest to largest category in terms of the number of times issues were raised during the research (from least frequently to most frequently raised). These are depicted in Figure 6.1 which provides a summary of the sentiments. A detailed discussion of each category is provided under sub-categories which depict specific examples of issues that were raised. The sub-categories partly emanated from the literature as well as from the interview data, that is: a priori codes and emergent codes as defined in Stuckey (2015). While emergent codes arise from the analysis process, priori codes are predetermined and are derived from literature review. In this research, these codes were derived largely from the six research themes: cleaner fuels, fuel economy, fuel switch, technology switch, modal shift and non-motorised transport.

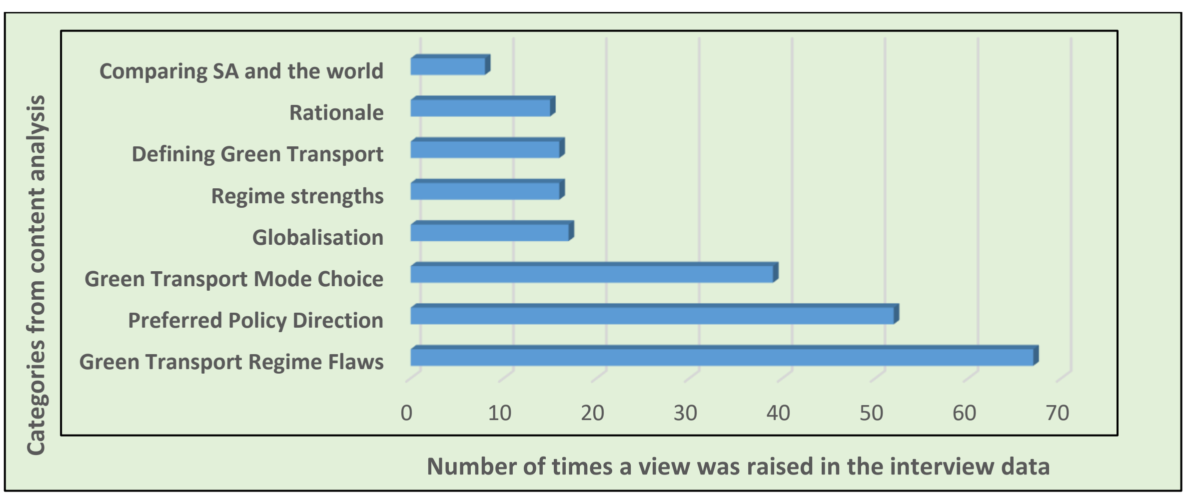

Figure 6.1: Summary of views on the SA Green Transport Regime (source: by author using content analysis techniques)

For ease of discussion, however, some categories are grouped together reducing the total number of chapter sections to seven, including the introduction and the conclusion. These categories were derived from content analysis of primary as well as secondary data described in Chapter Four. The data sources include 17 in-depth interviews as well as 15 official reports alluded to in Chapter Four. The two themes: *defining green transport* and *rationale for transport greening* share much in common, and as such are discussed first in order to set the scene. Although they each appeared a few times, it is believed that all other views that were raised more often (such as *green transport regime flaws*, *preferred policy direction* and *green transport choice of mode*) were based on the principles inherent in the definition the respondents assigned to the phrase "green transportation". The definition and the rationale are hence seen as providing a foundation for the discussion of these other categories. Other categories that appeared a few times were *comparison of South Africa with the rest of the world*, *regime strengths* and *globalisation*, as shown in Figure 6.1. While the first two categories are discussed together, due to a number of similarities in terms of issues raised, globalisation is incorporated into the discussion under the second largest category (*preferred policy direction*), and specifically the manufacturing sub-category. The most significant categories in terms of the number of times raised in the research are *green transport regime flaw*s, *desired policy direction* and lastly, the *preferred mode of green transportation.* These categories are discussed later in this chapter in the order of the listing above (which is from the largest to the smallest).

6.2. Defining green transport and rationale for the transition

Most interview respondents were officials serving in Government and hence the assumption that the definitions they assigned to green transportation reflect not only their sentiments, but also the policy positions of the departments they represented. The idea was to understand their world views in the context of a variety of sustainable/ green transport perspectives introduced in Chapter Two. Given the many drivers to transport sector greening, it was deemed important to understand the views of officials on issues of importance to Government. The definitions of respondents for transport greening were found not to differ much from the perspectives and definitions given by authors, agencies and organisations in the literature reviewed in Chapter Two. Generally, a choice was made between leaning towards the social, the economic or the environmental pillars or towards all pillars, with a bias towards the environment pillar in the respondents' definitions.

6.2.1. Defining transport sector greening

Figure 6.2 indicates that most definitional issues raised during the research had an environmental perspective, just one pillar of the sustainable development framework introduced in Chapter Three. Only two definitions took a balanced view, incorporating all pillars of sustainable development framework, with only one highlighting the socio-economic pillar. This related to the need for South Africa to diversify energy sources in a manner that ends the country's reliance on imported petroleum products. The 2018 highest price of fuel in the history of South Africa was seen as a security of supply risk, requiring the country to explore more alternative fuel technologies. Other green transportation definitions could not be aligned with any of the sustainability pillars. They related to issues that require policy clarity such as paddling and engine powered vehicles which, according to one respondent from the Department of Transport, still have a single definition. It must however be noted that Figure 6.2 may only be true if one assumes that greenhouse gas (GHG) emission is a purely environmental issue. This is the author's chosen view in this research, i.e. a view based on the belief that the creation of greenhouse gases and the resulting global warming is purely a physical environment issue.

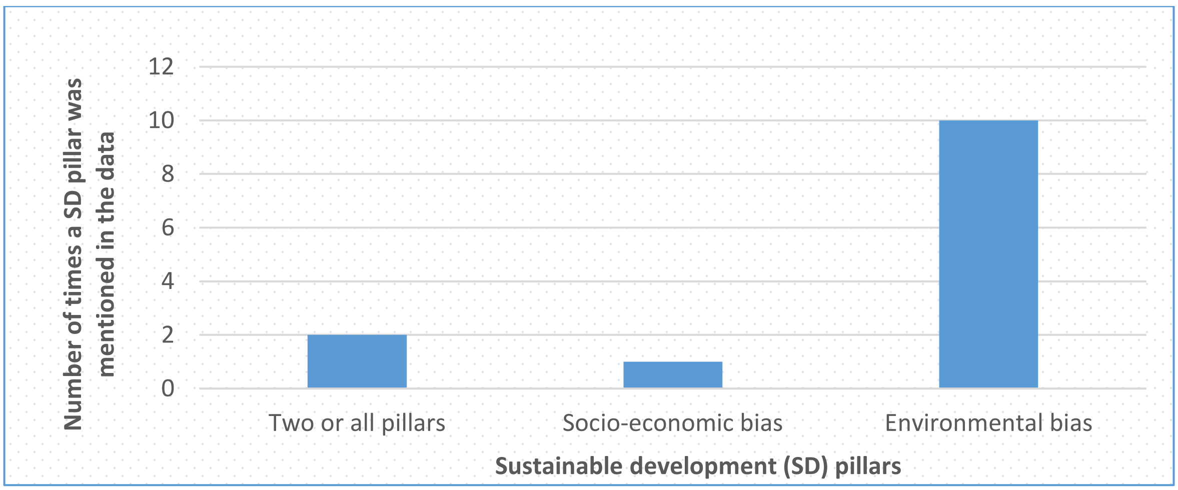

Figure 6.2: Defining green transportation (by author from content analysis)

There is chemistry involved irrespective of whether the gaseous sources are anthropogenic or natural. The emission of greenhouse gases causes warming of the atmosphere, termed "global warming". The scientific definition of this is therefore purely environmental as it refers to the alteration of the physical environment – the atmosphere often defined in the NASA's website as follows:

> Global Warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere (Twain, 2020).

To further support these arguments, some of the environment pillar-biased views on transport greening definitions extracted from the interview data are listed in Table 6.1. The definition assigned to transport sector greening in this table is green-oriented. It is, however, acknowledged that if one takes a closer look at the long term effects and broader implications of GHG emissions including changes in climate, it may be tempting to regard GHGs as a socio-economic phenomenon. The emission of GHGs, as is the case with automotive tail pipe emissions, is indeed a socio-economic issue as well, as it is caused by humans. The source of emissions is anthropogenic and the long-term implications will also impact heavily on the socio-economic systems.

Table 6.1: Views on green transport definitions (by author)

'…. From my thinking, emissions and environmental pollution – these contribute to global warming. So we have to deal with that. We need to opt for alternatives in the transportation and coal fired stations….' (TK, 2018).
'Best way to answer it … focus on specifics. The operative word "green" indicates the nature of this. When you use it, planet earth should remain without/ with minimal disturbance on it' (SX, 2018).
'Clear policy, improved efficiencies in transportation and technologies leading to low carbon' (R, 2018).
'Green transport – economy/ country move away from fossil fuel dependent transportation. A move to low carbon transport' (MM, 2018).
'Efficiency in the industry – sustainability – move away from using energy from combustion, instead use energy that is clean' (MHan, 2018).

The impacts, to name a few, include floods, droughts, desertification, wild fires, changes in terrestrial chemistry, reduced biodiversity species, rising sea levels and possible damage to coastal developments; reduced agricultural yields and poverty as a result of drought and poor rainfall (WWF, 2016 and USGCRP, 2017). These impacts have both socio-economic and bio-physical environment implications.

6.2.2. Rationale for transitioning to green transport

There was a very clear correlation between the definitions assigned to the phrase "green transport" and the reasons why this sector should be made green. For both aspects, views were biased towards the environment pillar. A total of 15 views were linked to the latter with environment bias accounting for around 67% of the total views on green transportation drivers. Very few responses cited ill health / occupational health or impact of tail pipe emissions on human health as the main driver for transport sector greening in South Africa. The balanced view (i.e. favouring all sustainable development pillars) accounted for only around 27%, with the rest at around 6% being related to the socio-economic pillar.

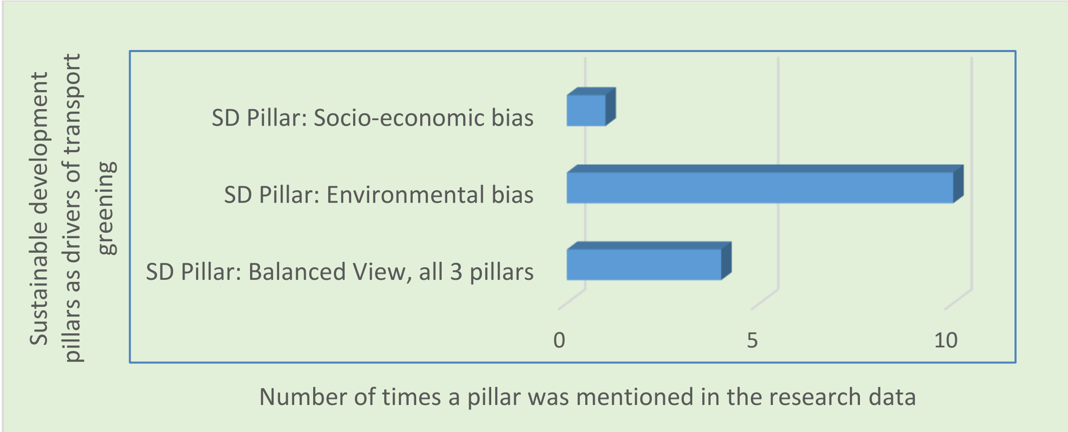

Figure 6.3: Rationale / drivers for transport sector greening (by author)

The environment bias can be illustrated from the following quote, which gives a context to the origin of South Africa's fuel specifications developed by the Department of Energy:

> … climate change/global warming has emerged as an environmental challenge in recent times, caused by high levels of greenhouse gas emissions. These emanate largely from the operations of the industrial, electrical and transport sectors. The transport sector being also a significant contributor to the greenhouse gas emissions prompted the DoE to tighten fuel specifications to reduce emissions from vehicles (DoE, 2017: 4-5).

This statement gives an impression that the primary driver for South Africa to embark on tightening the fuel specifications, was climate change. What is interesting about the presentation from where this quote was extracted is mentioning of the following socio-economic considerations, which underpinned the setting of fuel specifications and standards:

- Promotion of international trade, with emphasis on enabling the South African vehicle manufacturers to export technologically advanced vehicles to international markets.
- Extending benefits to the motorists in the form of fuel efficiency and lower vehicle maintenance costs.
- Keeping abreast with global trends in vehicle technology in a manner supported by enabling fuels.
- Supporting government's industrial development efforts geared towards employment creation (DoE, 2017: 4-5).

Based on the statement that the tightening of fuel specifications and development of standards, was largely driven by the transport sector's large contribution to the GHG emissions, gives the impression that the four bullet points above, only served as add-ons since the primary drive was to address GHG emissions from transport. To put this discussion in the context of South Africa's National Climate Change Response White Paper of 2011, the Department of Environmental Affairs (2018) noted that South Africa's commitment to reduce GHG emissions by 34% in 2020 and by 42% in 2025, was indeed conditional. It was subject to the developed world's commitment to support developing countries financially, and through capacity-building and technology development and transfer (Department of Environmental Affairs, 2018). Developing fuel specifications and committing to embark on transport greening initiatives, has its roots in the desire to align South Africa's efforts with global aspirations towards a low carbon transportation industry. It is therefore tempting to argue that, without such global support, South Africa will not be able to meet its commitments.

The bias observed towards the environment pillar in defining green transport, highlights the power of the environment department to influence decisions of other departments in facilitating necessary policy / legislative reforms using climate change as a primary driver. The environment pillar appeared most important to interview respondents in this research, as was the socio-economic pillar illustrated using the case of the Department of Energy.

6.3. South Africa's green transport strengths compared with the world

South Africa is believed to be generally following other countries in this area. However, there was a general feeling that this country has a number of strengths as shown in Figure 6.4 below.

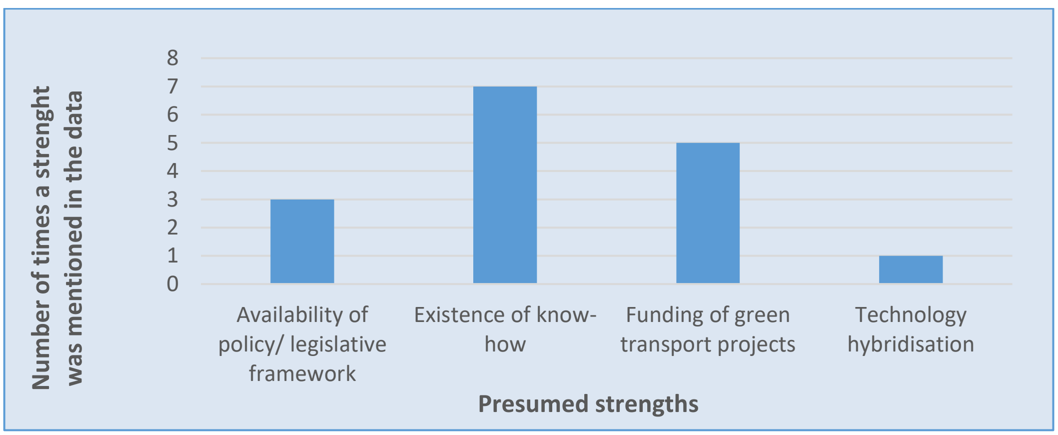

Figure 6.4: Presumed strengths in the current transport greening regime (by author)

The interview respondents believed these strengths to be key in elevating South Africa to a position not far from the rest of the developed world. Most strengths cited relate to the country's know-how as well as its willingness to fund green transport projects. The Industrial Development Cooperation (IDC) as well as the Development Bank of Southern Africa (DBSA) as government funding institutions were cited as playing critical roles in funding green transport related work. Nonetheless, the number of strengths raised was relatively small (only 16 compared to the 67 times regime flaws were raised – see section 6.4). If one were to compare South Africa with the rest of the world in terms of green transportation strengths, people interviewed generally rated South Africa low. The range of diverse views are shown in Table 6.2.

Table 6.2: Views on South Africa's regime compared with the world (by author)

'Very difficult to compare SA with developing/ emerging countries because not much is happening in those countries in terms of green transport development. Rather, compare SA with developed countries. But also, if you do so, SA will be underrated since these countries have done a lot of work in this area already. They started many years ago' (TS, 2018).
'Countries like the US, Spain and Italy – state fleet/ public fleet procurement is tested in these green technologies. This worked well in these countries. Significant investments and infrastructure built is done at state levels, with the quantum spend done at this level. Government runs the fleet for about 5-10 years, through an international operator. Perhaps SA can try this model where state procurement is involved' (SM, 2018).
'Very difficult to compare SA with other developed countries – some technologies would be case by case while others would be in terms of the collective, e.g. biofuels incentives' (SX, 2018).
'SA is well behind compared to other countries. Climate response strategy we keep referring to this' (PM, 2018).
'South Africa is lagging behind when equated to other key global players, but is not doing very bad comparatively' (MM, 2018).
'*We are far behind other African countries in terms of cleaner fuels. You see, there is a carrot and stick approach. SA Government prefers the stick approach, e.g. emission tax imposed on new vehicle sales. I prefer the carrot approach' (NL, 2018).*
'We are nowhere in South Africa. No tangible policies on GT. We see ongoing research; it never ends, but no final decisions on the right things that need to be done (GK, 2018).
'In Africa, we are number one. In Kenya, I presented the GTS work and the low carbon economy standards. Forty countries were present there, and after finishing the presentation, attendants agreed that they are not there yet' (BK, 2018).

The interview extracts reveal the diversity of opinions among the respondents interviewed about South Africa's position/ progress in greening its transport sector. The respondents demonstrate different levels of understanding the nature of and levels of development in other parts of the world with respect to transport greening. However, what stands out clearly is the view on how far behind South Africa is compared to other players at global level.

6.4. Green Transport Regime Flaws

Around 67 items were raised as weaknesses of the current approach to green transport development in South Africa. Spread across 11 sub-categories as shown in Figure 6.5, lack of coordination appeared the most (21% rating). This was followed by too much subsidisation of the status quo at 13%, rent seeking/ lobbying at 12%, choice of unsuitable mode/ technology at 10%, competing priorities at 10% and other additional (six flaws) below 10% as shown in Figure 6.5. Commencing with lack of coordination, these flaws are discussed in the ensuing sub-sections.

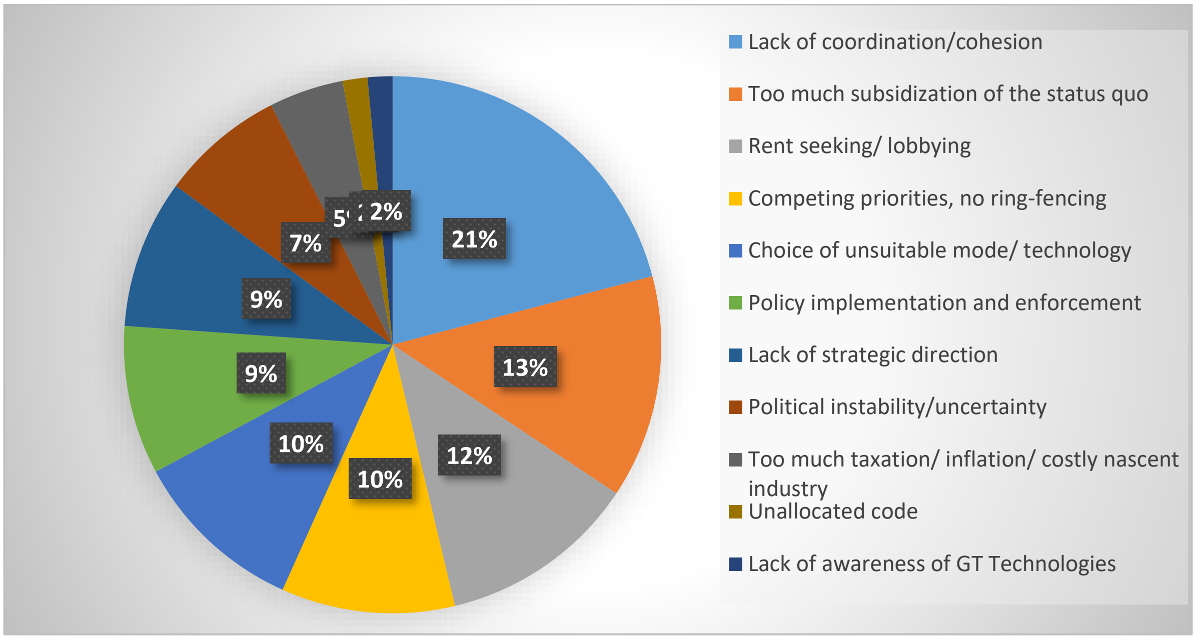

Figure 6.5: Views on green transport regime flaws (by author)

6.4.1. Lack of coordination

Lack of coordination relates largely to the planning, procurement, compliance enforcement and operation related deficiencies. Half of coordination concerns were raised at municipality level and relate to the management of various public transportation modes including the subsidised as well as non-subsidised bus and minibus-taxi services. The structure of the municipalities and the way they deliver transport related services was at the centre of concerns as can be noted from the following quotation:

> One thing I learned from China is that, government created red tape for itself in order to exist. So the same can be said about South Africa. In South Africa, there is no coordination – everyone seems to be doing different things. There is a policy certainty issue, which hinders investments in the green transport industry. Is RSA really into this? What if it pulls out when so many investments have already been made? The municipal pilot project as an example, the Development Bank of Southern Africa and the Global Climate Fund are willing to fund but metros are seen as both project sponsors and implementers (TK, 2018).

Regarding the procurement of green buses, it should be noted that the large metropolitan cities do different things, with the City of Cape Town, City of Tshwane and City of Johannesburg having followed completely different routes with regard to the procurement of green buses. Three different types of green buses were procured: electric buses by the City of Cape Town, CNG buses by the City of Tshwane and dual fuel (conventional diesel and CNG) buses by the City of Johannesburg as reported in Mahomedy (2019), Sandton Chronicle (2014) and Matlhale (2015). Presenting at the 2018 *Competition Commission's Market Inquiry into Land Based Public Passenger Transport Sector*, Nxumalo (2018) argued that the National Land Transport Act prohibits municipalities from becoming referees and players at the same time, where only the City of Tshwane and the City of Cape Town are currently doing this. In its presentation to the Competition Commission, the City of Johannesburg Transport Department (2018) acknowledged this stating that it operates Metrobus and is also a contracting authority in respect of Rea Vaya Bus Rapid Transit (BRT).

An organisation called the South African Cities Network has done some work to assist municipalities towards a common sourcing and procurement of green goods and services including green buses. This organisation encouraged resource sharing between these cities. This organisation, however, never succeeded in achieving the common procurement of green buses it had aimed for in these member metropolitan cities. In its report to the Competition Commission, the City of Johannesburg (2018) noted their limited relationship with the company that runs the Gautrain and how this company's expansion plans, were not aligned to the municipal land use and transport plans. Sometimes the issue of unnecessary competition for routes was raised, e.g. Gautrain bus service running along the same route as the Rea Vaya buses (City of Johannesburg, 2018). Additionally, it is very common in the City of Johannesburg to witness minibus-taxis using the lanes dedicated to the Bus Rapid Transit (BRT) bus drivers. Some of this behaviour is attributed to the deficiencies at provincial regulatory authority level, as denoted in the quotation below:

> Lack of regulation by the provincial regulatory entity (PRE) and the city means that the minibus taxi sector regulates itself or is 'regulated by third parties' – sometimes with inappropriate sanctions and rewards – and legitimate operators may lose out (City of Johannesburg, 2018: 25).

By virtue of the minibus-taxi industry being mainly in private hands, the City of Johannesburg (2018) noted that the ability of the state to organise this mode in line with a public transport plan is very limited. This is, according to this organisation, worsened by the lack of government regulation and enforcement, hence creating a 'free market' environment for operators in the minibus-taxi industry. As such, this raises philosophical and strategic questions of whether this industry should be regulated or not. In their report to the Competition Commission, the City of Cape Town's Transport and Urban Development Authority (TDA Cape Town) (2018) noted that the implementation of BRT in South Africa has been challenging to implement well. This is partly due to the fact that it requires penetration into highly contested urban road space and involves new types of bus operations (TDA Cape Town, 2018).

As already alluded to, red tape and policy uncertainty are coordination deficiencies which do not occur only at municipal levels; they are also reported at provincial and national levels. These relate to alternative fuels (specifically compressed natural gas and biofuels) as well as automotive manufacturing. Energy is indeed not the competency of Government at local and provincial levels. It is constitutionally mandated at the national level, with lack of clear policy direction on suitable alternative energy such as compressed gas and biological fuels likely to impact negatively on the work done at municipal levels, which is where most procurement takes place.

> For me, if you look at development, various players are doing various things, but development is not moving at the pace it should be moving at. Other technologies are not at the level where one would want to see them, e.g. CNG minibus convention. This worked, but did not achieve acceptance from Government. No coordinated efforts, instead there are pockets of activities, here and there. So with this, where is this sector going? Also, the Joule car, it profited oversees entrepreneurs but in South Africa, not much support was given to this project (TS, 2018).

Converting minibus-taxis to run on compressed natural gas requires sustainability of gas supply and policy certainty regarding the use of gas in vehicles. Currently this type of gas is imported from Mozambique with national legislation not yet declaring it as an acceptable fuel for the transport sector. As a fuel to promote sustainable transportation, gas is currently unregulated under the Gas Act (Act No. 48 of 2001), hence creating uncertainty about potential future direction by the regulatory authorities. The Gas Regulator Levies Act (Act No. 75 of 2002), as noted in Chapter Five, gives powers to the National Gas Regulator to impose, vary and/or set interest on levies. So, it is possible that at any given point in time, this imported gas may have levies imposed on it. While a treaty was signed in 2001 (i.e. the Gas Treaty of 2001) between the South African and Mozambique governments for the latter to provide the gas to the former, the deal depends on many factors, including political stability between the two countries. As noted in the quotation above, these issues leave many unanswered questions on the part of investors wishing to make investment decisions in South Africa. Government policy at national level is seen to be lacking in terms of declaring certain fuels as acceptable in the transport industry, while development of certain fuels, most notably biofuels, is moving very slowly as can be seen from the statement below. Lack of coordination according to SX (2018) is still there, e.g. biofuels. Engagement at Government level has been going on since 2005, but ten years later, there is still no biofuel plant (SX, 2018).

Transport greening was described by MB (2018) as an intergovernmental issue, hence requiring policy cohesion. Using a different term "eco-mobility", this respondent further described green transport as an ecosystem issue which should touch on all aspects of mobility such as infrastructure, safety, etc. But he noted much duplication on, for example, Research and Development (R&D), and lack of integration between the departments. Examples quoted include lack of justification for the highest fuel price in 2018, and the highest electricity tariff by Eskom in the same year. The question as noted in the quote below is,

> …what should people do when both fuel (petrol and diesel) and electricity that can be used to charge electric vehicles go up at the same time? This is like punishing people, while at the same time not giving them alternatives – that is the main cause of concern here. The challenge in SA is therefore lack of integration, with one department doing one thing while the other does the opposite (MB, 2018).

GK (2018) cited the issue of 'over promotion' of certain environmental imperatives without due consideration of their potential negative effects on the socio-economic aspects of national imperatives such as employment creation. One part of Government promotes the manufacturing sector while another part of the same Government seems to be punishing this sector through the use of supply reduction tools such as the carbon tax, high electricity prices, high fuel prices, etc. (GK, 2018). This respondent viewed this as a serious coordination challenge relating to activities at the national sphere of governance.

6.4.2. Over-subsidisation, rent seeking, unsuitable modes and competing priorities

These four flaws have been grouped and are discussed together in the sub-section that follows.

6.4.2.1. Over-subsidisation

The largest flaw (in terms of number of times raised) was lack of coordination already discussed in the preceding sub-section. The four flaws discussed in this sub-section are grouped together as they shared almost the same number of appearances in the interview data at around 13%, 12%, 10% and 10%. Raised nine times over 67 flaws, over-subsidisation accounted for around 13% of the overall issues raised, second after the lack of coordination flaw at 21%. All issues on over-subsidisation relate to bus contracts issued at provincial level by Provincial Transport Authorities. Most respondents who provided this criticism were officials at municipalities, with the following statement made by a municipal official at the Competition Commission Market Inquiry Into The Land-Based Public Passenger Transport Industry:

> In South Africa, over half a billion/annum on subsidies goes to the land transport sector. There is other money that goes to rail and as such funding is limited. How do you optimise? There is hence duplication of scarce resources here. BRT is trying to address that, with bus and minibus services having to play a feeder role (Wosiyane, 2018).

Interestingly, this statement promotes the Bus Rapid Transport (BRT) model which, for some reasons, gets attacked at provincial level, with critics, notably AA (2018) citing the BRT's failure in providing a much-needed public transport service in the Gauteng province. The quote below elaborates on this official's concerns:

> …the BRT is failing, and they have been keeping quiet, but slowly they are coming out. There is a grant that they got, as well as a huge loan that has to be repaid to the Development Bank of Southern Africa. The challenge is that these buses are operating at a loss. The BRT lanes are not open to the general public transport. But only to the BRT buses, which from time to time, run empty (AA, 2018).

Another big problem that AA (2018) highlighted is that South Africa is creating a reliant society, e.g. providing grants that cater for learner transport. At the same time, there is too much cross-subsidisation already happening in other areas such as students and elderly persons who benefit from various transportation services such as the BRT, social grants and rail commuting. While stressing that she was not anti-old age, this official wished to highlight points to illustrate cross-subsidisation in South Africa. An official at national level also raised a related sentiment when lambasting subsidy model schemes offered to the BRT and public bus operators. A critic at the national level of governance questioned the greenness of grant/ subsidy schemes, citing specific examples such as the Public Transport Network Grant (PTNG). This scheme is not designed to cater for green transportation (MM, 2018). As noted in the guideline document by National Treasury and Department of Transport (2018:6), the main criteria to receive a grant is that the interventions must be 'fiscally and financially sustainable', i.e. affordable over the long term. The guidelines still make it a requirement for grant recipients to conduct a so-called "alternative analysis". This is a prerequisite for the selection of any projects. This analysis contains criteria that includes all pillars of sustainability, including a recommendation to consider social, economic, financial, environmental issues as well as land use and cost effectiveness before deciding on the best transport investment option for the Integrated Public Transport Network Pan (National Treasury and Department of Transport, 2018:33).

At least on issues around over subsidisation of transport services, there are synergies between officials serving at municipal, provincial and national levels, where they all cite the limitations of the subsidy models employed in South Africa. The major difference is that at municipal level, the BRT system is praised as a useful solution to address transportation challenges, whereas the provincial servant heavily criticised the BRT for having failed dismally in providing a much needed public transport service. It is also important to note who is excluded from the subsidy schemes – an issue that has emerged several times in the interview data. In setting the price, a national body representing minibus-taxi operators, the South African National Taxi Council (SANTACO, 2018) argued that subsidised bus operators factor in the subsidy, whereas minibus-taxi operators take into account the plight of poverty and unemployment faced by commuters. As such, this results in price differentials depicted in Figure 6.6, in this case, as reported in Gauteng province. The vertical axis depicts prices in South African Rands, while the horizontal axis depicts kilometres travelled by various transportation modes.

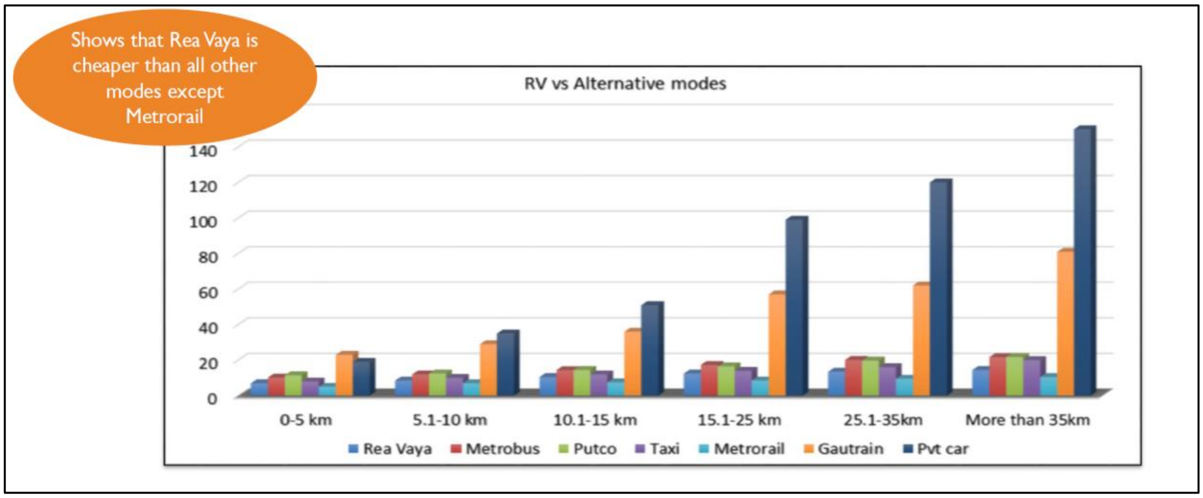

Figure 6.6: Rand price comparison of transport modes in Gauteng (CoJ, 2018:21)

The minibus-taxi industry, one of the country’s oldest modes of green transportation, is not benefiting from the subsidy in its original form. Indirectly, they do however benefit in the form of the taxi recapitalisation programme (TRP), reduction of e-toll fees, and building of taxi ranks by authorities. As an intervention by Government to bring about safe, effective, reliable, affordable and accessible taxi operations, the TRP required all old minibus-taxis to be scrapped, in exchange for money from the state (South African Government, 2020). By 2015, a total of over 61 000 old taxis had been scrapped with a total payment of around R3.4 billion for scrapping allowances (South African Government, 2020). Nonetheless, SANTACO’s concern is that the minibus-taxi industry is compromised by either joining hands with beneficiaries of the new government system (the BRT) or leaving the business after accepting a particular form of compensation. Incidentally, this industry provides a form of green transportation which the majority of low income public transport users rely on for daily commuting to and from various destinations. The quotation below from a SANTACO respondent may provide an insight on why this *green transport* provider may no longer be seen to be providing a sustainable mode of transportation:

> The difference in pricing has a huge impact on competition between various modes. In most cases the rail and bus commuter obtains a subsidy to board that mode at a reasonable fare, which then places a burden on the taxi operators to charge a fare that will not be profitable, but would only allow for the payment of operational costs with no profit in order to survive. Other routes cannot even pay for operational costs, leading to intra disputes between members as they enter other operator's routes in an attempt to make cash. In some cases, vehicles become repossessed, or get serviced at unreputable workshops or operating without insurances – hence putting commuters at risk (SANTACO, 2018:2).

This association however highlights other fragmentation challenges within the sector itself which it says, limit it from transforming, exploring and taking advantage of new opportunities within the industry. These include, among others, the family structure nature of their business, lack of managerial and financial skills (SANTACO, 2018). Besides the unfair competition arising from unfair subsidisation, the national policy and legislation, according to SANTACO focuses on restructuring existing services in a manner that creates a monopoly for the bus and rail modes, while penalising the minibus-taxi industry. The Integrated Rapid Public Transport Network (IRPTN), according to this organisation, calls for restructuring, including a need to create high capacity corridors to be serviced by bus and rail modes. They regard this as a systematic removal of competition aimed at creating a way for new companies to operate on the BRT routes, and they blame this on incapable and inefficient municipal officials (SANTACO, 2018). Wosiyane (2018) of eThekwini Transport Authority noted that what the BRT is trying to achieve is resource optimisation, with the bus and minibus services having to play a feeder role. So, this can be built into contracts, and as such it should not be viewed as a competition issue. 'As a pure economics demand and supply issue, this should work in an integrated manner', noted Wosiyane, while emphasising that people go to trains because they are cheaper. So the idea from the Transport Authority's side is that one ticket can be used to access all modes of transport available, e.g. from a train to a minibus-taxi, without incurring additional costs (Wosiyane, 2018). eThekwini Municipality is going ahead with the BRT system, despite criticisms as already alluded to above. The reasons that this municipality stated for this decision relate to this metro's BRT system being newer compared to Gauteng and Western Cape BRTs. As such, lessons from these municipalities can be used to address potential challenges that the eThekwini Municipality might encounter (Wosiyane, 2018).

6.4.2.2. Rent seeking/ lobbying

Economists, according to Henderson (2019), utilise the concept of rent seeking to describe preferential treatment that people or companies seek from government agencies. A better word according to this writer however, is 'privilege seeking'. To a certain extent, the flaw discussed in the previous sub-sections (over subsidisation) has elements of rent-seeking. In Figure 6.5, this appeared as the third largest flaw mentioned by the research participants as it accounted for about 12% of the total number of flaws cited. More specific examples of rent-seeking reported in this research include those in the Table 6.3. These cut across the automobile technologies including the conventional internal combustion engine (ICE) technologies and the alternative technologies including electric vehicles and hydrogen fuel cells. On the lobbying side, electric vehicles were mentioned more than these other technologies. In his presentation at the Sustainability Week conference, Jordaan (2018), a prominent player in the South African EV battery industry, said "you must not listen to lobbyists". This presenter is very active, promoting anything EV and criticising other automobile technologies, in a manner that creates the impression that he is an EV lobbyist. As one member of the audience noticed what looked like lobbying tactics, this presenter was soon challenged for excessively praising EVs over other technologies. The presentation was also criticised for strong criticism of Government as if nothing is being done at Government level, when much is being done at this level to promote green transportation.

Table 6.3: Lobbying quotation from the interview respondents (by author)

'The petroleum sector has a vested interest to keep the status quo. They are very strong – policy wise. They seem to have coordinated themselves very well' (TS, 2018).
'Impala committed to converting all of 50 buses from diesel to hydrogen fuel cells in Rustenburg. This would send a strong message about SA's commitment to this technology. Anglo American committed to putting money on the metro buses … through the C40 Bus declaration – signed between two metros – Tshwane and Johannesburg'(TK, 2018).
*'At EVIA, **the dti** is viewed as an important player to provide some guidance on a number of these issues. **the dti**'s role and presence in these forums is considered to be of critical importance. SA to develop manufacturing capability for small engine and efficient vehicles for export to Africa' (R, 2018).*
'Enabling policies depends on what you want. People lobby for specific policies depending on the specific technologies they want to see' (MT, 2018).
'Currently there is an existing industry within SA therefore the industry needs to be careful of the technologies and regulations that it imports. Already in EVs there are two types of plug points in charging stations; should more plug points be imported this could be problematic' (WJ, 2016).

This audience member highlighted EV limitations, such as their inability to match the ICEs in performance over aspects such as speed during vehicle take-off. The point made here is that lobbying exists in the promotion of new technologies such as those targeting greening in the transport industry. It is argued here that this is the kind of reality that policy makers experience, hence challenging them to either take sides or to remain objective. The EV industry, according to TS (2018), is organising itself very well. Until associations form in other transport greening sub-sectors, standing up and lobbying Government, nothing much is likely to happen according to this respondent. TS gave the example of the wind industry, stating that it was not a coincidence that this industry got so much share in the Government's Renewable Energy Programme. It was all due to this rigorous lobbying through the industry association. The Electric Vehicle Industry Assocition (EVIA) is doing something along those lines as they try to speak in one voice for the EV industry in SA (TS, 2018). Following rigorous lobbying by the electric vehicle industry in South Africa, a study funded by UNIDO (2018) provided insights on potential socio-economic and environmental impacts of electric vehicle roll-out in the country. Conducted by a consortium of service providers, the report arrived at the following conclusions regarding massive roll-out of electric vehicles in South Africa:

- Reduced imports of crude oil;
- A potential increase in Eskom value add;
- A significant reduction in transport-related GHG emissions (substantially more so than if more efficient ICE vehicles were enabled through the transition to cleaner fuels);
- Lower health, road accident and social welfare costs;
- Improved energy security and reduced exposure to volatility; and
- Improved local air quality (UNIDO, 2018).

While the costs will include reduced Government revenue, reduced liquid fuel sector value, job losses and infrastructure costs, these primary costs are however far outweighed by the benefits, with the key policy challenge being how to best manage the transition (UNIDO, 2018). However, this study could not say by how much these benefits outweigh the costs, making it unclear how this conclusion had been reached. Instead it stated that, 'it is difficult to tell how at risk the South African liquid fuels sector is to negative EV-related impacts', and the extent to which liquid fuel dynamics in the country pose a risk to the automotive industry (UNIDO, 2018: 29). As noted, this initiative formed part of a series of initiatives to 'build a case for electric vehicles' as noted in the executive summary of the research by UNIDO (2018). It is therefore concluded in this thesis that some sort of positive end statement was needed, indicating that a case has indeed been built. It is always challenging trying to be aware of potential bias in studies.

6.4.2.3. Choice of unsuitable mode/technology

An issue that relates to over subsidisation is a concern around Government tendency to adopt transport modes that are unsuitable. The definition of what is suitable and what is not suitable is dependent on who is making the claim. One mode that has received much criticism on various grounds is the Brazilian-based, now 44-year-old, bus rapid transport system (BRT), which seems to be still working well in South America as noted in Boucherat (2020). Cities on this continent are deemed to have higher population densities compared to South Africa as recorded in Worldometers (2020). Heavy criticisms of this system have been raised at different levels in Government and in the industry, as noted in the previous sections citing SANTACO (2018), Wosiyane (2018), CoJ (2018), MM (2018) and AA (2018). Critics cite many failings of this system in South Africa, which include its inability to make much-needed profits and recover costs – only 40% of its operating costs can be recovered. The buses are unable to attract sufficient numbers and hence run empty on a regular basis, staying idle while communities revert to the minibus-taxis they always complain about (AA, 2020). This respondent is of the view that the BRT lanes are not open to general public transport, being exclusive to the BRT buses. Instead, the minibus-taxis should be allowed to drive in these lanes; they use them anyway already. As noted in Kneale (2016), these taxis transport about 16 million passengers a day, spending an average of ten hours a day on the road. In most cases, they are the only reliable and convenient source of transport. These views seem to imply that minibus-taxis are a “suitable” choice of mode. Wosiyane (2018) argued that an integrated system, which recognises all modes of transport, is what is required.

As noted in Kneale (2016), the public transport sector has undergone a series of transformations through Government interventions lately. Some taxi operators have had to give up routes to make way for the BRT system. At times, they have been paid up to R830 000 per taxi as compensation. While the City of Cape Town’s Transport and Urban Development Authority (2018) praises its MyCiTi BRT service for having been relatively successful in terms of bus occupancy rates, it also acknowledges that fully replacing minibus-taxis with BRT is not affordable across the city. Thus it tried new approaches, which are a ‘hybrid’ between BRT, improved traditional buses (referred to as “quality bus service”) and minibus-taxis. This line of thinking (i.e. an integrated and multi-modal approach) seems to be aligned with thinking presented by Wosiyane (2018) of eThekwini Transport Authority. This official acknowledged that the BRT system is not a panacea for all transportation challenges in the city. In the City of Tshwane, currently the Ayereng BRT service does not reach out to townships located in the city periphery, including the township of Atteridgeville. There are plans for reaching out to these areas. The City of Johannesburg Rea Vaya BRT system extends to the township of Soweto. Unsurprisingly, the minibus-taxi industry does not support the BRT, with SANTACO (2018) noted as saying that the BRT was introduced in order to get rid of the minibus-taxi industry.

Being a public transport mode, the BRT naturally fits into the green transport pyramid by Urban Hub (2020) as introduced in Chapter Two. With these buses using alternative fuels such as CNG in the case of Cities of Tshwane and Johannesburg as reported in Sandton Chronicle (2014), Matlhale (2015) and (Mcilhone, 2015) and electricity in the case of City of Cape Town, these modes also align with the *'shift'* and *'improve'* parts of the A-S-I model as depicted in Figure 2.2 extracted from GIZ (2016) in Chapter Two. From an environmental perspective, the BRT is indeed a greener mode of transport. The positive impact extends to the socio-economic pillar since a certain percentage of components of these buses, such as the bodies, are by law now required to be sourced locally. Section 9 of the PPPFA (Gazette No. 34350 of 2011) empowers the Department of Trade and Industry to designate certain industries, sectors and sub-sectors that are of 'critical importance' to stimulate local manufacturing by organs of state and public entities. Bus bodies are now designated in terms of this section and as such, procuring officers are by law obliged to procure buses with bodies comprising a minimum local content level of 70% to 80% depending on the category of buses procured (National Treasury, 2012).

6.4.2.4. Competing priorities

As discussed in the previous section, the issue of competing priorities appeared seven times, giving it a 10% score from the overall 67 flaws mentioned in the research data. These are diverse issues, which nonetheless provide some insight into respondents' views on the performance of Government in transport greening. They provide insights on the challenges facing Government when trying to motivate for policies supporting the transition to a greener transportation regime. There are many competing priorities within Government according to SM (2018), and as such, greening and sustainability are key concepts that South Africa needs to take into consideration. Primary drivers according to this respondent, however, are the socio-economic conditions that the state operates under in the country, which include the need to create jobs and develop the economy. GK (2018) argued that this country needs money for a variety of needs including education, housing, health and others. When South Africa is struggling to fund these basic needs, how, asked this respondent, will the country get money to fund transport greening initiatives?

In its presentation to the Competition Commission, the KwaZulu-Natal Provincial Department of Transport (2018) views limited funds as a key hindrance to the drafting of Integrated Transport Plans (ITPs). Consultants who provide services to develop these plans according to this Department, charge for their services, and the budget allocations do not always allow for this to be implemented as municipalities prioritise other projects. Some additional views, as summarised in Table 6.4, reveal other issues, which serve to highlight the competing priority debate presented in this sub-section. The views presented in this sub-section talk to different areas of focus in South Africa, with some aligning with the transport greening agenda. The views are as competing as the priorities themselves, with some views questioning the rationale for transitioning to green when this country is not yet ready, while others question the rationale for not speedily transitioning to green. Resource scarcity is highlighted as one issue that constrains the ability to achieve transport greening imperatives.

Table 6.4: Additional views on Government competing priorities (by author)

'What are the Government priorities? DST on fuel cells, but uncertainty. That is very damaging to the Government. The NAT MAP should not differ much from the GTS. The transport strategy of 2009 was stopped but was the best strategy till today. The fuel economy standard. Final commitment? The transport month? A lot of good things on this, however we need transportation discussion that will be translated into implementable actions. Currently, this is not done well' (R, 2018).
'During the GTS development, we had proposed EV charging from solar PV only. However, with the newly built power stations, Medupi and Kusile, we got our hands squeezed to say that the EVs would be charged from this additional capacity from new power stations. This is more like replacing one devil with the other, unless the new power stations are all fitted with state of the art pollution abatement technologies such as flue gas desulphurisation, etc' (BK, 2018).
*'There is however this issue of levies and ring-fencing - National Treasury and **the dti**. Why should we ring fence and why can't we use the money collected to fund green transportation?' (AA, 2018).*
'Minibus-taxi competition with Rea Vaya and Metrobus (including use of the dedicated bus lanes) leads to a loss of fare revenue which needs to be made up with a greater operational subsidy. Intimidation of bus passengers by minibus-taxi operators existed but has declined' (CoJ, 2018:25).

The respondents highlight trade-off issues between the need to attain basic needs and attainment of green goals. These debates fall well within the sustainable development debates and models introduced in Chapter Three, notably the original phrase from WCED (1987) as well as other writers such as Willard (2010), Hahn, (2014) and Lotz-Sisitka et al (2017). It is a sustainable development debate on what should the Government prioritise – the daily needs of society or the environmental protection imperatives? "Sustainable development" as a phrase calls the world to appreciate the existing connection between the socio-economic and biophysical environmental pillars (Allen and Ervin, 2007); sustainable development theories therefore become relevant when trying to understand the respondents' views in this sub-section. After all, South Africa, as noted in the Department of Environmental Affairs (2019), has developed a position, which emphasises that a move towards the green economy does not necessarily require the coupling of resource use with environmental impacts from economic growth. This recognises that socio-economic growth can take place, along the same route as environmental protection, and therefore there are no trade-offs.

6.4.3. Lack of strategic direction and other flaws

The additional six flaws, all scoring below 10%, are shown in Table 6.5. These were also grouped together for ease of discussion and they account for about 34% of the total views on green transport regime flaws. The first three are the largest and as such, are discussed the most fully. Regarding lack of strategic direction, several issues were raised across the green transportation pyramid/ value chain, including the indecision on the initially planned tram running from Johannesburg CBD to Soweto, the discarded projects such as the Joule car, the incomplete CNG pilot projects, ongoing and non-stop research on hydrogen fuel cells and the indecision to finalise the decision of migrating to Euro 5 equivalent cleaner fuels. There are also non-decisions on the use of alternative fuels such as compressed natural gas as well as the replacement/ discarding of South Africa's own invention – the minibus-taxi industry.

Table 6.5: Other flaws identified from interview data (by author)

Flaw	Number of times mentioned in data
Lack of strategic direction	6
Policy implementation and enforcement	5
Political instability/uncertainty	5
Too much taxation	3
Lack of awareness	1
Unallocated code	1

South Africa, according to AA (2018), has a tendency to start a project and not finish it: *'we try this, once it fails, we drop it and try something else'.* These projects are given up before the country can start reaping the benefits. All this can be attributed to the lack in strategic direction. An example of this was demonstrated at the Industrial Participation Action Plan (IPAP) sessions facilitated by the Department of Trade and Industry in 2017/2018. Following a presentation which raised concerns about the influx of under 1000cc vehicles in South Africa from the European Union and the EU's strict targets for green vehicle rollout, the Minister in the Department of Trade and Industry requested advice from participants on the best future mobility technology for South Africa. The question was whether the country should go for electric vehicles, hydrogen fuel cells or any other greening technology. No definitive advice could be given to the Minister. Politicians require guidance from sector experts, but if they are not getting this, they can easily make uninformed political decisions. This statement links to the flaw raised on political instability/ uncertainty raised during the interviews. Most issues raised under this sub-category were linked to the political set-up in the country during the time of writing this chapter. The larger metropolitan areas in South Africa, e.g. the City of Tshwane, the City of Johannesburg, the City of Cape Town, the city of Durban and the City of Ekurhuleni are run by political rivals – the Democratic Alliance (DA) on one hand and the African National Congress (ANC) on the other. While coalition features prominently in some, as was the case in the City of Tshwane, between the Economic Freedom Fighters (EFF) and the DA, often disagreements affect smooth operation within such municipalities, hence affecting service delivery as reported in the Mail and Guardian by Rabkin (2020). At the time of finalising this thesis, the City of Tshwane was placed under administration, with court battles still going on between the ruling political rivals.

When it comes to decision making, these rivals may not always agree on certain issues as can be noted from the quotation below regarding a special purpose vehicle company established to drive platinum group hydrogen fuel cells:

> An SPV between 3 metros – COJ, COT and Ekurhuleni – a concept document is in paper already. It is designed to run in 2 phases, with 4-10 pilot vehicles first. The challenge with this SPV is political changes that happened. The 2 metros, one is run by the DA while the other is run by the ANC. There is heightened willingness on the part of the ANC-run metro, but a bit of reluctance on the part of decision makers, given the fact that they do not want to be seen to be supporting the ANC-led metro (TK, 2018).

Political instability here relates to changes inter and intra parties. In other words, any changes from President Zuma to President Ramaphosa as noted in 2018, could also mean new priorities on the part of the new president. The same could be true with changes in Ministers of departments that have an influence on the green transport legislative and policy environments, as can be noted from the extract below from a provincial official in KwaZulu-Natal:

> Green transportation as an overlapping issue, is indeed bound to face challenges that come with this chopping and changing of political heads. So, these are real life treats to the success of these initiatives. Commitments by one leader for example, often get ignored by the next leader, hence creating a real uncertainty to the developments moving forward (MH, 2018).

Politicians are also blamed for placing too much priority on the socio-economic pillar to the detriment of the environmental pillar, with AA (2020) naming a politician who once used words such as "we cannot stop development because of butterfly eggs". Politics, according to SX (2018) can work wonders but South Africa currently lacks the "make it happen" or "killer punch". Certain projects such as the Gautrain project have received considerable support. Advocacy at provincial level, according to this respondent, pushed and pushed until this modal shift intiative, was even given a name "Shilowa Train" after the provincial premier at the time, Mbazima Shilowa. This demonstrated the presence of political will and the Gautrain continues to provide a unique and useful service. Despite the reluctance of national Government, the provincial government, according to SX (2018), pushed for this initiative to be realised.

Some concerns were also raised about the South African Government's love for revenue collection using tax. The main concern here was that South Africans are already overtaxed, with the recent 1% increase in the value added tax (VAT) making the life of citizens even worse. This and other related concerns discussed above could be addressed through mechanisms proposed in the following sub-section.

6.5. Preferred Policy Direction

This section provides views on the kind of policy and regulatory framework, which the interview respondents deem necessary for South Africa. First it must be noted from Figure 6.1 that the *preferred policy direction* category was the second largest category in people's perception of green transportation policy regime in South Africa. A total number of 52 codes (views) were identified, accounting for about 23% of views received. For ease of discussion, these codes were further grouped into six sub-categories. Most codes focus on a need for better incentives, enhanced local manufacturing and a need for South Africa to be creative/ think outside the box/ adopt indigenous solutions when it comes to transport sector greening. A summary of these views is portrayed in Figure 6.7, with further details in subsequent sections. It must, however, be noted that due to the closeness between South Africa's preferred policy direction and issues at a global level, views on globalisation are also incorporated into the discussion in this section. This means while Figure 6.1 portrayed globalisation as a stand-alone category, for ease of logic, it is presented here under the *preferred policy direction* category, under the sub-categories linked to local manufacturing and creativity.

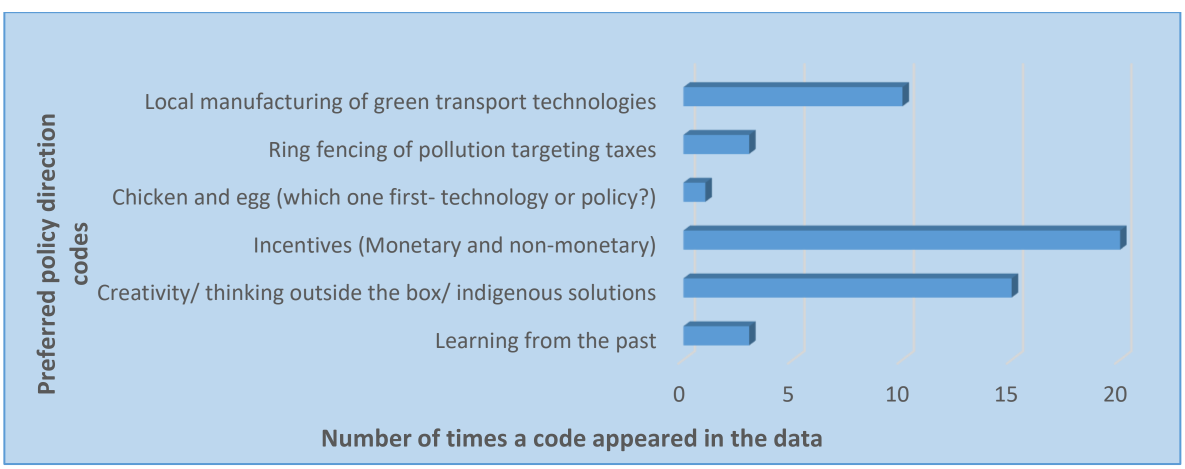

Figure 6.7: Views on preferred green transport policy direction (by author)

6.5.1. Better incentive environment

A call for better incentive mechanisms was raised about 20 times in the interview data, making this policy direction the most preferred route. What does this mean given that Government (as discussed in Chapter Five) already provides a number of incentive mechanisms to encourage various modes and technologies of green transportation and fuels. The call is for both fiscal and non-monetary incentives, with the former describing market-based instruments, mostly preferred by MM (2018) as they provide a certain level of flexibility during implementation. While some call for a combination of tools such as subsidies, taxation and regulations as noted in the responses from GK (2018) and MHan (2018), there are common sentiments against taxation. This is mainly due to the belief that South African consumers are already overburdened by tax, with BK (2018) citing carbon tax, fuel levies and environmental (emission) tax as examples. Addition of more tax is likely to discourage investments and further uptake of green modes of transportation. This view was shared by respondents such as PM (2018), NL (2018), BK (2018) and AA (2018). These respondents prefer softer ‘carrot’ measures such as subsidies. NL (2018) noted that SA Government prefers the ‘stick’ approach, e.g. emission tax imposed on new vehicle sales, and the ‘carrot’ approach according to this respondent still has a role to play.

The impact of tax depends on how it is used. In situations where tax is used as a punitive measure, as is currently done in South Africa with the environment (CO_2) levy imposed on conventional automobiles, the case for a higher tax is justified. As noted in SARS (2020), this tax is used to punish buyers of vehicles of specific automobiles that are deemed to be emitting more CO_2 than others. In this case, a higher tax on these vehicles should in principle discourage their use, hence encouraging the use of less polluting or greener alternatives. Tax can also be used to encourage buyers of green vehicles. Citing the import duty on EVs, MH (2018) argued that the taxation system is high, making it too expensive to buy these green vehicles. Reducing import duty on these vehicles should in principle encourage their purchase, as explained in the simple demand and supply curves by Radcliffe (2017) in Figure 5.3. While MM (2018) deemed regulations to be less effective as they do not provide much flexibility, as a tool, some respondents did not discard them completely; they provided examples of areas where regulations are still useful. These include standards or compulsory regulations on projects such as EV charging infrastructure when targeting those who can afford in order to enhance compliance. A limitation of regulations, according to MM (2018), is that while they are needed to complement market based instruments, they are not easily adjustable, and they also do not encourage improvement beyond what they stipulate. Also tax is not discarded as an option as there are circumstances that call for it, such as in cases where people cling to fossil fuels. In terms of the best incentive route, MT (2018) advised that it is best to make a comparison analysis before deciding on the best incentive. LA (2018) shared a similar sentiment, emphasising the importance of conducting research before deciding on the right tool. There was general agreements that projects must be prioritised to incentivise them.

In Chapter Five, many examples were cited to highlight how well the status quo is subsidised in South Africa. This includes conventional automobile manufacturing, e.g. the automotive scheme (APDP) as described in the Department of Trade and Industry (2017) as well as conventional fuel exploration and production as noted in Lott (2016). Also, it was noted in the SARS Customs & Excise Tariff Book (2018) how the rebate system also extends to vehicle models of headings 8704.21.81 and 8704.21.83. These vehicles include double-cab and single-cab petrol and diesel powered automobiles. Also, the National Treasury Budget Vote 35 (2016) gives an indication of subsidies offered to public and road transport. It was therefore argued that all these grants, subsidy and rebate schemes help preserve the status quo. They do not encourage a shift from road to rail, nor encourage switch to greener fuels nor a switch to the manufacturing of greener automobiles. Hence, any new subsidy, according to MM (2018), should divert from benefiting the current state of affairs as this leads to the price of these products being far below the actual costs of their use. They are deemed to be regressive, hence benefiting high income families/ users of such goods.

To create a link between the arguments above regarding oversubsidisation of the status quo and dissatisfaction about too much government taxes, it is important to note that higher taxes fund the subsidies. Higher taxes are also justified in cases where fossil fuels (dirty fuels) and ‘dirty vehicles’ in this case, are targeted. One example to highlight this can be found in the radio interview response by Maqubela (2018) of the Department of Energy. In an interview session with Bongani Bingwa of 702 Radio about the fuel levy and the 2018 fuel hikes that were maddening motorists and politicians, Maqubela was recorded as saying:

> The Department is looking into this matter and the President Cyril Ramaphosa is also looking into it. We are not alone in this fuel hike, prices are up all over the world and the fuel levy increase has already been factored into the budget, and hence any removal/ or reduction has to be counteracted by an increase elsewhere to make up for the loss of revenue (Maqubela, 2018).

The interview alluded to the possibility of tapping into the demand side to recoup losses from the fuel levy, in case Government decided to reduce it as a way of ameliorating the fuel price situation. Regarding the question on fuel price deregulation, Maqubela (2018) cited concerns around potential job losses, saying that the industry hires over 50 000 people, especially in the filling stations. In Government, tax is therefore justified for obvious reasons that relate to it being one of the major revenue collecting tools as noted in Mohr, Fourie and Associates (2015). To back the statement made in this radio interview, MM (2018) was recorded as arguing along the same lines as this official from the Department of Energy. While more critical of the basic fuel price, this respondent agreed that fuel price deregulation is a very sensitive issue. It is a route which Government fears on the basis that it will shut small players out of the business, leaving the large multinational companies monopolising the market. However, deregulation has potential to enhance competition, leading to the introduction of diversified products hence giving consumers more product choices. Currently, South Africa, as noted in NM (2018) and in Miller (2019) is stuck with old technology vehicles due to the absence of suitable fuels (such as Cleaner Fuels 2) to power the latest technology vehicles.

Generally, respondents in this research cited subsidies as the most preferred fiscal measure, capable of stimulating developments in the following green transport technologies/modes:

- ❒ Public transport, mainly the minibus-taxi industry, which is currently excluded from specific subsidies received by other private bus operators including the BRT.
- ❒ Biofuels, especially if the projects are distributed fairly among various communities.
- ❒ Electric vehicles, especially the reduction of import duties.
- ❒ Infrastructure, especially designed to charge alternative fuel vehicles.

Subsidies and other demand-pull measures according to MT (2018), allowed sudden take-off of greener automobiles in countries such as Norway. Much was discussed in Chapter Two about how demand-pull incentives assisted Norway, China, Brazil, USA and other European Union countries, speed up the uptake of green automobiles. These measures were discussed in Ou et al. (2019); Hardman et al. (2018); Yingqun (2017); Forbes Media LLC (2017); Centre for Climate and Energy Solutions (2019), among others. Even in SA, the automotive industry (as can be noted from the quotation below extracted from an interview session with one respondent) did not grow out of nowhere:

> It is true, enabling policy is needed. Green Transport is not an easy task, it is costly and requires some commitment on the part of Government. e.g. the RSA automotive sector did not grow without Government support. In the 1960s, enabling conditions were created in order for this sector to thrive. Incentives/ subsidies and international agreements allowing SA to export certain vehicle types, were created. One example is Mercedes Benz, whose local market is very limited. Most of these vehicles are exported to the affording countries. Also, what we have produced far exceed the local demand, so we have to export more units (GK, 2018).

According to this respondent, while the industry will surely show interest in automobile greening, it will however expect Government to offer them something in return. Another respondent was cited as going back to 2008, alluding to the point that incentives were provided to promote progress following the recession (NL, 2018). One interpretation of this could be that the automotive industry is dependent on receiving government incentives. Hence in section 6.4.2, the over subsidisation of the status quo was highlighted as one of the most serious flaws in the history of South Africa's transportation industry. All respondents who called for subsidies did this within the context of transport sector greening. The respondents however cautioned against irrational provision of subsidies, as these may have long term unintended consequences, impacting negatively on the long term sustainability of subsidised projects. TS (2018) in particular, cautioned that to avoid unintended long term consequences, policy makers should design subsidies correctly, ensuring that they are fit for purpose. As discussed in Chapter Two, China used subsidies successfully to promote the adoption of green automobiles. However, after realising the long term costs to the fiscus, this country gradually shifted towards adopting supply-push measures, hence its New Energy Vehicle (NEV) scheme resembling California's Zero Emission Vehicle (ZEV) schemes discussed in Ou et al. (2019) and Hardman et al. (2018).

The use of fiscal instruments can be powerful due to, among other reasons, their flexibility, argued MM (2018). They tie well into the discussion on interventionist theories introduced in Chapter Three, notably Argyris (1970) who laid down specific requirements for any intervention to become effective. Funded from taxes and from other revenue streams of governments, subsidies and other support measures such as rebates have been used in South Africa to fund many status quo programmes in the transport industry. Various examples were already highlighted in the previous paragraphs. These measures however, have created a reliant society as argued in AA (2018). One key requirement for intervention to become a success, which Argyris (1970) laid down, is sustainability of the intervention. This means that, once the interventionist has left, the system should not die, but continue sustaining itself for as long as its existence is relevant and justifiable. To address sustainability issues of subsidies, the following recommendations emerged from the data:

- ❐ The subsidies should be targeted at benefiting the poorest of the poorest through community development.
- ❐ Subsidies should be provided to maintain affordability.
- ❐ Due to fiscal constraints in SA, the subsidy must target the most efficient mode of transport.
- ❐ Young people aspiring to acquire a vehicle could be subsidised if they are first time buyers of fuel efficient vehicles.
- ❐ Subsidised conventional public transport providers should be subjected to local content and greening requirements.

Respondents proposed a number of other monetary and non-monetary incentives to green transport promotion. Presented as a summary, these recommendations are not different from the incentives discussed in Chapter Two, where they have been adopted successfully in major green transportation countries. The recommendations are as follows:

- ❐ Exempt green fuels from paying the Road Accident Fund (RAF) and the fuel levy;

- ❒ Provide tax breaks and rebates,
- ❒ Awareness and training first,
- ❒ Dedicate lanes for users of green vehicles, including buses and minibus-taxis,
- ❒ Incentivise the construction of new infrastructure or reconfiguration of existing roads to encourage use of NMT such a walking and cycling,
- ❒ Restrict passenger car usage at certain times of the days,
- ❒ Build and provide charging infrastructure for electric vehicles and compressed natural gas, while at the same time, providing incentives such as feed-in tariffs, where excess electricity can be fed into the grid.

To achieve most transport greening according to SX (2018) requires that South African policy decision makers '*think outside the box'*. It requires a certain level of creativity, which embraces the wealth of knowledge, including indigenous solutions as discussed in the following sub-section.

6.5.2. Creativity and indigenous solutions to resource development

This was indeed the second largest preferred policy route after the incentives discussed in the preceding sub-section. It was mentioned about 15 times in the interview data compared to about 20 times the incentives proposal was raised. It provides pointers in terms of where Government's starting point should be in terms of taking green transportation work forward. The respondents come from different disciplines and departments and hence their views were not always congruent. What seems common among the respondents was that, South Africa, like all other nations has its own uniqueness. As a result of this, South Africa should take advantage of this by building on its key unique features. One example to highlight this relates to this country being endowed with many mineral resources, which if beneficiated, can add value to the economy. These materials, including Platinum Group Metals, aluminium, and certain grades of steel, according to Barnes et al. (2018) and IDC and **the dti** (2017) represent core areas of potential sustained competitive advantage for the South African automotive industry. As noted in Anglo American Platinum (2017); Robertson (2017) and Ballard Power Systems Inc., (2011), Impala Platinum and Anglo American have rolled out fuel cell projects in their mining operations, including fuel cell powered underground locomotives. Like other African countries, as noted in the International Energy Agency (2019), South Africa has the richest solar resources on the planet. It is also rich in other reserves of minerals such as cobalt, uranium, manganese and platinum that are crucial for clean energy technologies. As a key player in the global automotive ecosystem, there is potential for South Africa to play a significant role in the production of automotive components that can feed into this global ecosystem, e.g. cathode and anode materials for EV batteries and fuel cells. South Africa is a semi-periphery country, which however still forms part of the global village. Chapter Three provided arguments from Robinson (2007); Wu (2016); Hurst (2018) and Major (2013) on how semi-periphery and periphery countries like South Africa get controlled by core countries. While these countries have power to control what gets done in countries like South Africa, they cannot control what these countries really *want* and *can actually* do. The statement below provides one example of an indigenous solution, which one respondent provided to emphasise this argument:

> Why don't we develop indigenous products? Let us talk about the taxi industry – some kind of a fuel cell taxi? This is a unique industry, not available anywhere in the world. India, maybe? China as well, but mainly on the delivery side? As a numbers game – many people in SA use minibus-taxis, not buses. There is indeed an infrastructure issue (TK, 2018).

Transporting over 16 million passengers a day, as indicated in Kneale (2016), the minibus-taxi industry is South Africa's heritage, born out of desperation as a response to the segregated apartheid spatial planning (Barrett, 2003 and Mackay, 2020). Even after the eradication of apartheid-based human settlement policies, major urban centres according to Vosper and Mercure (2016), have continued to sprawl outward away from city centres. Given the lack of transportation services in these areas, the taxi industry continues to play a significant role in providing the necessary commuter services. As an already green mode of commuting, if viewed from the context of green transportation pyramid by Urban Hub (2020), it however holds more potential when these vehicles are powered from greener fuels. Instead, efforts according to Santaco (2018) have focused on eradicating this sector through *'unscrupulous practices'*. The author learned about a proposal by one key player in the local NGV industry, to convert minibus-taxis to run on compressed natural gas, with the banking community and the dealerships showing interest in this model (HS, 2018). Here, the taxi would be converted while still new and sold to a customer already in a converted form. It should be noted that this country already has the know-how and experience in the conversion of minibus-taxis and municipal buses to run on dual fuels (conventional petrol and compressed natural gas). Figure 6.8, depicts one such example. There is an element of recycling here, where, instead of taking an old vehicle to a scrapyard, it is simply recycled this way. SX (2018) raised crucial points about potential invention around the old Government fleet, including military vehicles. The quote below explains this respondent's idea:

> … in rural areas, the situation is so bad that, there is no movement of things. A lot can be done including demonstration of green technologies, e.g. disposal of Government fleet such as trucks from the military. These can be converted to CNG, biofuels for use in difficult rural terrains. In the process, this country will be learning while at the same time addressing the real transportation problem that these remote areas are faced with. So after going to clearance, why not take these vehicles (as most of them should still be in a driveable condition), explore with the national Department of Transport on the conversion

of these machines. We should not just say, CNG, Biodiesel, EVs, but let us rather look at the indigenous solutions (SX, 2018).

Figure 6.8: A CNG converted minibus-taxi (source, by author in 2014)

In research by ASSAF (2014), the retrofitting of automobiles with devices that allow them to use greener fuels, was listed as one of the available solutions for South Africa. ICEs could be retrofitted to use electric power, CNG, LNG, biofuel, hydrogen fuel cells or hybrid systems. The retrofit concept is undeniably not new, with NGV Global News (2018) having reported the success of Italy's NGV retrofit programme. A country that has over 75% of NGVs in the European Union, Italy is deemed to have the oldest retrofit industry dating back to the 1970s. Government incentives of over 25 million euros made available via specialised workshops and dealerships, ranged between 650 to 2400 euros / vehicle (NGV Global News, 2018). The relevance of this retrofit story in South Africa, relates to this country' legislated support as stipulated in the Waste Management Act (Act No. 59 of 2008). This Act promotes the *'waste hierarchy approach'*, which recognises efforts that encourage in chronological order, the avoidance, minimisation, reduction, reuse, and recycling of waste products, with disposal only supported as the last resort.

BK (2018) reminded the author that South Africa is diverse and has both rural and urban provinces. Policy makers therefore need to cater for the needs of all these beneficiaries when it comes to creating a transport service. Calling it *'some kind of a roadmap'*, SM (2020) proposed a gradual shift from one green technology to the next, as opposed to overnight changes. The argument here is that if this route is not followed, there tends to be a displacement effect. This response seems to be in line with the argument presented by Morden (2012) that a sustainable transport system must be achieved step-wise, not shock-wise to allow it market and political acceptance. As noted in Tovey et al. (2017), the short-term activity should promote incremental improvement in fuel efficiency and vehicle emissions controls. Long-term goals, according to this writer, involve as switch from conventional fossil energy to alternative and greener sources. To do this well, the starting point according to MT (2018) and LA (2018), requires life cycle assessment, a scientific exercise to compare the costs and benefits of the status quo with futuristic technologies. This assessment is supported on the grounds that it will allow the market to guide the process in terms of what is best for South Africa, hence avoiding the tendency of lobbyists that promote their solutions, leading to biased and uninformed decisions by policy makers. MT (2018) made an example of Norway, saying that this country developed good policies and incentive programme which assisted greatly in promoting electric vehicle uptake. As time went on, Norway started experiencing unintended consequences, where many of these previously subsidised EVs were now causing traffic jams in transit lanes dedicated to high occupancy vehicles such as buses (Aasness and Odeck, 2015). In their observation from Oslo toll ring, these writers noted that travel time on transit lanes has increased with proportional increase of EVs using transit lanes. In addition, Steinschaden (2019) argued that the free charging stations led to these stations being overrun continuously, with Norway in 2018 losing around 3 billion krone in revenue due to the many subsidies for electric cars.

The main conclusion from this sub-section is that, South Africa is endowed with many resources that are critical in green transportation debates. However, when this country decides to embark on any greening initiatives, it should do so after carefully studying the initiative and its alternatives, hence gaining clear understanding of its life cycle effects. In the process, creativity and consideration of indigenous solutions, should form part of the execution strategy.

6.5.3. Enhanced local manufacturing and impact of globalisation

The message here is that South Africa should start manufacturing green vehicles and associated components and supply these not only to the developed world markets, but also to the African region. The demand for green automobiles however is in the developed world countries, which have set stringent fuel economy and emission standards. As noted in the AIEC (2019) export manual, these countries such as USA, Japan and Germany, also house major Original Equipment Manufacturers (OEMs), who in turn, control what should go to the supply lines. Nonetheless, South Africa successfully produced an electric car (the Joule as stated in the previous sub-section). It pioneered the zebra battery, the lithium ion manganese spinel, Sasol's Fischer-Tropsch process (although not a green innovation), thin film solar photovoltaic technology, to name a few (ERC, 2013; Alfreds, 2012; van Dyk et al. 2019). In fact, the thin film solar panel has been dubbed as *the first wholly African-designed and -built solar panel*. All these case studies highlight that this country has the know-how. The next question may be, what happened to these local inventions given the call for creativity and use of indigenous solutions as proposed in the preceding sub-section?

Being a global player has its challenges. The legal battles over patents in the case of the solar PV thin film story are simply the tip of an iceberg of real issues that South African think tankers and innovators have to deal with. Even the failure of the Joule electric car could be linked to global issues, e.g., which global OEM with a presence in South Africa had a relationship with this project? Government's requirement for 50 000 units (as noted in **the dti**, 2017) to qualify for government incentives could have been the issue. Maybe the Joule was too early and there were many unforeseeable risks. Global linkages including competition and politics are all issues that South African inventers and think tankers have to deal with. The aim of this desired option (as raised by interview participants) is to promote local inventions in a manner that will encourage ideology and technology flow from the east to the west. So, specific technologies mentioned by respondents under the *local manufacturing* category are, electric vehicles, battery packs for these vehicles as well as catalytic converters. South Africa already manufactures catalytic converters for the export market, with this component having been the top automotive export component category in Rand value between 2017 and 2018 (AIEC, 2019).

While the future of catalytic converters is still questionable given the pronounced reduction in ICE powered vehicles and targets for EVs in South Africa's major automotive export markets, catalytic converters still have a market in the hybrid vehicle space. In the transition, this brand stands to form part of the transition from the current ICE to the fully battery electric vehicles and fuel cell vehicles, as argued in Barnes et al. (2018) and Brinson (2020). Catalytic converters have markets in the internal combustion engine era, with this country's ability to grow the catalytic converter business linked to the strict regulatory controls in developed countries, especially Western Europe (TK, 2018). South Africa is rich in the platinum group metals (PGMs) used to manufacture these components, and as such, comparatively large amounts of these little *'pollution busters'* have found their way to the export market (AIEC, 2019). Their demand as well as the demand for diesel particle filters was estimated to increase more than twice over a period of twenty years from 2012 (Dewar, 2012). They contribute a large share to this country's component export revenue as indicated in Figure 6.9 compared to other automotive components.

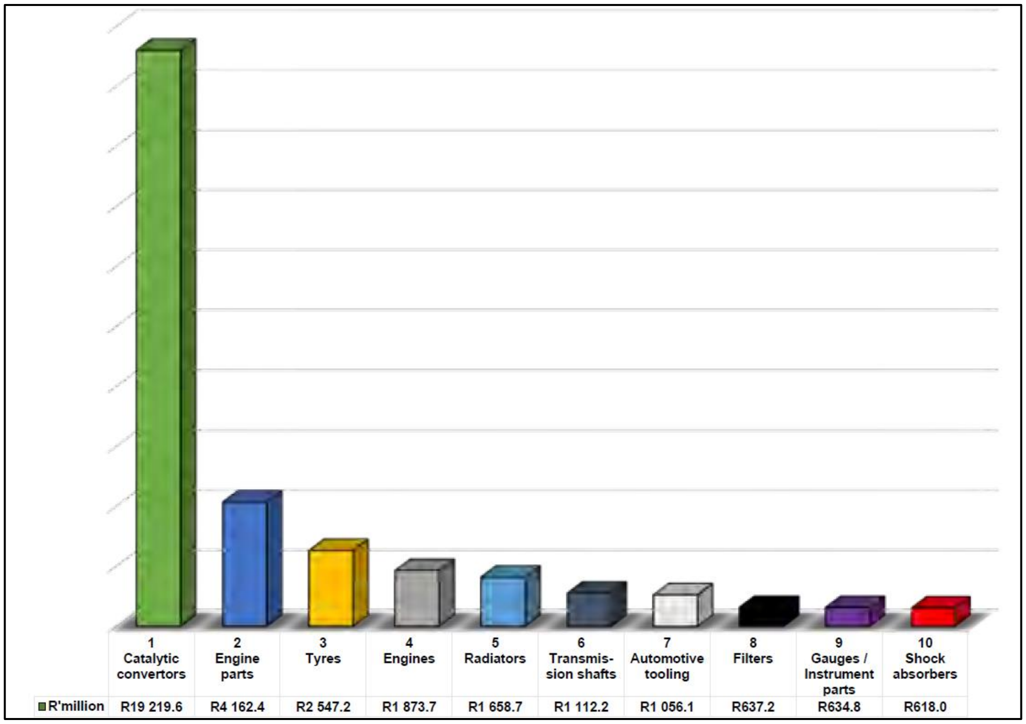

Figure 6.9: Catalytic converters as the highest automotive export component (AIEC, 2019)

Continuing imposition of strict auto emission regulations is also true for emerging economies of China, India, and Brazil, and this is believed to result in continued increase in the demand for catalytic converters. AIEC (2019) noted how South Africa's automotive master plan (SAAM2035) has factored in continued support for this country's catalytic converter industry by expanding their exports. Even though developments in the EV industry threaten these components, hybrid vehicles will still require catalytic converters, and as such they still have a market to the OEMs that include hybrid vehicles as part of their transition strategies. With its installed capacity for coating of PGMs, this industry is posed as a natural springboard for the development of technologies for producing alternative auto technologies like fuel cells. As such, the automotive master plan support according to AIEC (2019) extends to the fuel cell industry.

The role of globalisation, including the international value chains on South Africa's green automotive manufacturing, cannot be ignored. Figure 6.10 shows the number of times views on globalisation were raised by interview respondents in this research. This figure should be read in conjunction with Table 6.6, as the table provides a summary of specific issues shown in the figure.

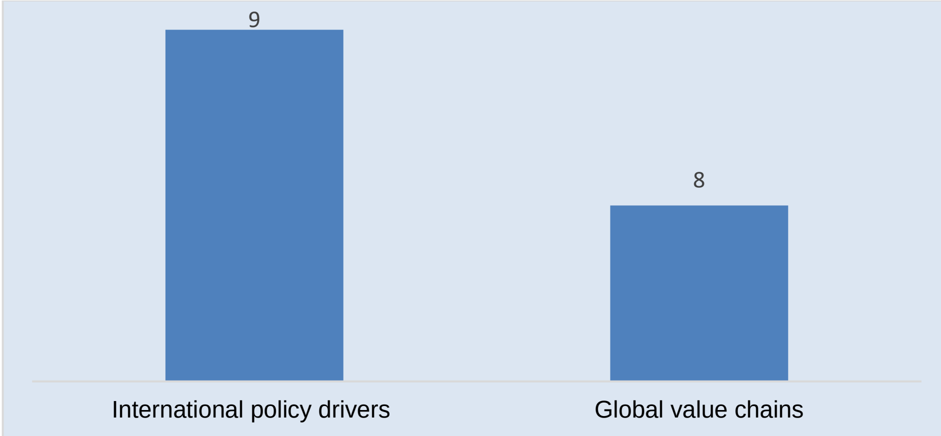

Figure 6.10: Number of times views on globalisation appeared in the data (by author)

Notwithstanding the global value chains, South Africa has leverage on what it can and what it cannot do in terms of automobile assembly in this country. It has control over the incentives that have partly kept these global OEMs glued into continuing with local manufacturing of automobiles. With appropriate fiscal measures, targeting the manufacture of green automobiles, it is argued that this country can steer the ship. This is another area where creativity, as discussed in the previous sub-section, is required, whereby the incentive schemes are redesigned to target local manufacturing of green automotive components and vehicles. The CEO of NAAMSA (South Africa's vehicle manufacturers association) was quoted in Engineering News (2020) as saying that the automotive industry is working with Government to develop a position paper on electric vehicles, which would be used latter to lobby their parent companies for a share of future EV production. In developing green vehicles for the export market, South Africa is deemed by some to be set back by a regulatory environment that is not conducive, as noted in MH (2018):

> Government needs to develop the supply chain and start to promote local manufacturing of green automobiles. If we do not start doing so, where will we sell our automobiles in the years to come since our export destinations are slowly moving away from ICE type of vehicles. We are going to lose the market as a country and start importing dumped ICEs from the rest of the world (MH, 2018).

As illustrated through various quotes in Table 6.6, global value chains control the means of production and the type of products that the South African and the global markets receive. So what gets done in South Africa seems to be largely influenced by these realities. NL (2018) believes that, as a technology taker, all this country should do is keep up with developments that are taking place internationally. South Africa, according to this respondent, relies on these international markets, especially Europe. Should these markets decide that they no longer need South African automotive products, there is little room for this country to manoeuvre.

Table 6.6: Views on the role of globalisation (by author)

'The EU Standards – about 44% demand on platinum was brought about by these standards. We would not have auto cat converters if it was not for the EU standards' (TK, 2018).
'Government-led initiatives to improve public transport must continue in line with international best practice, where Government plays a key role in the provision of public transport' (WC, 2018).
'International countries have set a target for EV roll-out and ICE discontinuation' (MHan, 2018).
'Climate change commitments and pressure forced different countries to avoid going on the direction of greenhouse gas emissions' (MHan, 2018).
'SA has signed many binding protocols, including the addition of emission tax on everything' (NL, 2018).
'We are not a developed world. Market still dictates' (BK, 2018).
'In developing the provincial green transport strategy, no specific legislation existed in SA. So the provisions in the policy were informed by what is in the international domain/ the international conventions. There is a provision somewhere in our national legislations/ constitution that, if there is no supporting legislation at national level, continue doing your policies based on what is happening at global arena' (LA, 2018).
'South Africa's commitment to reduce GHG emission by 34% in 2020 and by 42% in 2025 on condition that requisite finance, technology as well as capacity building is provided by developed countries' (JN, 2017).
'CNG conversion – all including conversion kits are imported from Europe' (HS, 2018).

The statements in the Table highlight a grim reality that South Africa is faced with, at least from the point of view of respondents who participated in this research. There are over seven leading international OEMs in South Africa who, under the Government's financial support programme, have already invested around R40 billion into the South African automotive industry, assembling vehicles both for the local and export markets (AIEC, 2019). It is argued in this research that, their strategic directions and what to manufacture are all controlled in their headquarters, located outside the borders of this country. These headquarters, decide on the vertical or horizontal structures of their businesses, and what lines of production to give to countries that mostly assemble the automobiles (OECD, 2016).

6.5.4. Other preferred policy routes

The three preferred policy routes shown in the table below are clumped together in this section due to the very small number of times they appeared in the interview data. They are however still considered important in the context of debates around transport greening. They include issues the following three aspects:

- ❒ Debates around what should come first regarding technology or policy (the chicken and egg debate),
- ❒ Debates on the ring-fencing of pollution targeting taxes,
- ❒ A need for this country to take a step-bac, learn from the past policy mistakes before deciding on the way forward.

Regarding views around what should come first (technology or policy), as mentioned in PM (2018), it is better if the South African Government allows market forces to introduce new technologies into the country, without much interference by the state. It is a view that Mkhize (2015), of the Department of Energy also raised in a gas seminar in Johannesburg, when responding to questions about the role of his department on gas use in transport. Government's delay in making legislative provisions for direct use of gas in transport has been done deliberately, as a way of allowing the industry to find its feet (Mkhize, 2015). This behaviour is true for technologies that are currently not regulated such as compressed natural gas use in automobiles as well as the conversion of old vehicles to electric. As noted in in the media statements by CEF (2017 and 2018) and CEF (2020), the fuel price in South Africa is regulated, but direct use of gas and electricity is not, and as such these fuels do not attract the fuel and the road accident fund levies. The fuel levy is applicable to goods that are classified as fuel levy goods in terms of Schedule 1 Part 5A of the Customs and Excise Act (Act No. 61 of 1964). So far these goods include fossil-derived petrol and diesel as well as biodiesel. There is indeed a 'chicken and egg' situation with regards to the introduction of new technologies. One respondent was quoted as stating the following regarding her views on this 'chicken and egg' debate:

> Get technology to the market. Let these technologies be seen and think about policies later. Example…City of Johannesburg, City of Cape Town and City of Tshwane went ahead, no problem. But what about accidents, insurance issue and Road Accident Fund. So, get the technologies to prove themselves first, then attend to these issues at a policy level (PM, 2018).

Also very few views were heard in relation to the ring-fencing of tax that Government levies on certain products. These normally include taxes such as that imposed on vehicles that emit carbon dioxide, plastic bag levy, the tyre levy and other related environmental levies. Two of the respondents who raised it are for ring-fencing, while one respondent was against it. Reasons cited for Government's dislike of this policy route can be traced from the following statement made by a senior official in one national department:

> Ring-fencing is not supported by Treasury – only the excise duty that was imposed to change behaviour gets slightly ring-fenced, e.g. the plastic bag levy. But look at the

> challenges such schemes have experienced over time in South Africa. Looking at how much we are subsidised in South Africa, with shrinking funds overtime, we would not be able to fund Government spending if we take the ring-fencing route. Example, the Road Accident Fund always go back to the transportation sector – but it always run out. Government needs money to spend on a lot of things, but our revenue sources are very limited, i.e. mainly VAT, Income tax, product tax. We do not generate a lot of revenue from Government business (MM, 2018).

The need for South Africa to learn from the past policy mistakes was raised three times. The best practice for the country, according to AA (2018) would be to look back, see what went wrong with projects and policy frameworks initiated in the past prior to giving up and moving on to other projects. This relates to MM (20180 and AL (2018) who brought in the life cycle assessment debate, arguing that this country should learn to study and analyse any tool, technology carefully before deciding on adopting and implementing it. This was based on the recognition that many competing technologies exist out there, and their propagators also want a share into this country's market. These respondents warned that South Africa needs to ensure that the technologies adopted will produce sustainable results. A statement from the Department of Trade and Industry's Industrial Policy Action Plan concludes this section, stating the following with respect to thorough researching before taking policy positions:

> The Industrial Development Corporation (IDC) has carried out an extensive analysis on alternate (and clean) transport fuels, backed by international studies and confirmed by SANEDI analysis. This shows that the cleanest and most efficient transport fuel supply options are natural gas and purified biogas (both being methane). These can be adopted in the short term, whilst electricity can be adopted into the vehicle market over the longer term (**the dti,** 2015:134).

This quote and the discussion on the 'chicken and egg' debate suggest the importance of not jumping to conclusions, rushing the decisions with insufficient information. The life cycle assessment advice and what looks like delays in Government to make decisions on new technologies, tie in well. The key advice is to take one's time and not to rush. One challenge with this approach is that developments in green transportation are occurring at a fast rate, with possibilities that South Africa will be left far behind, if it continues to move as slowly as the views suggest in this sub-section.

6.6. Green Transport Choice of Mode

Regarding views on the preferred choice of green transportation technology/mode in South Africa, these appeared as the third largest category mentioned about 39 times in the research data as portrayed earlier in Figure 6.1. This accounted for about 17% of views raised, after *preferred policy direction* and *regime flaws.* In chronological order from most to least preferred green modes of transportation were *technology neutrality, electric vehicles* and *modal shift* and the discussion in this sub-section focuses largely on these three technology choices. Other less popular views called for technology prioritisation/ picking hence specifying green transport technologies ranging from fuel cell, gas, biofuel, cleaner fuel to renewable energy powered vehicles. All choices are shown graphically in Figure 6.11.

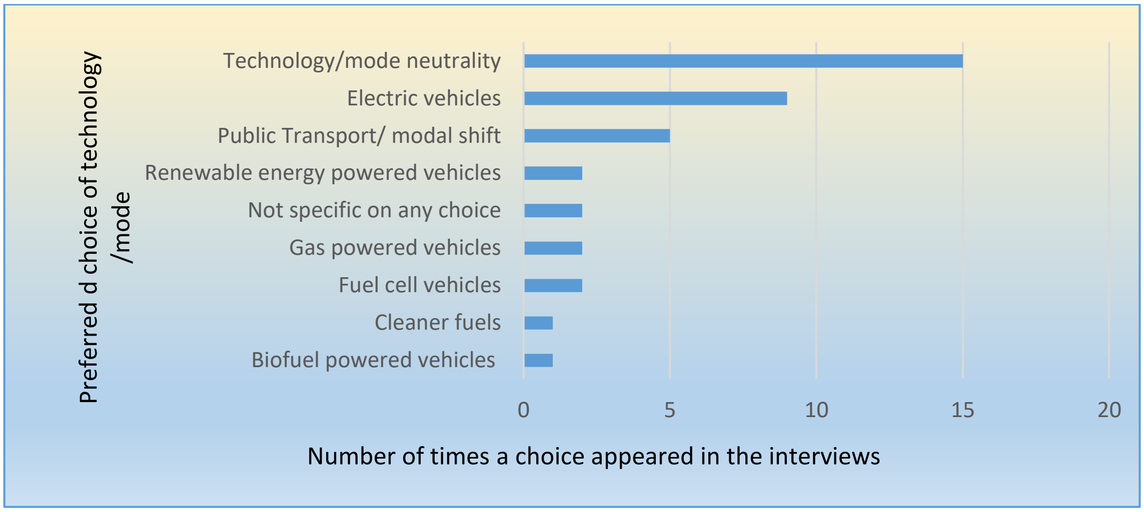

Figure 6.11: Preferred choice of green transportation technology/ mode (by author)

6.6.1. Technology neutrality

As a dominant sub-category, views on technology neutrality called for South Africans to not pick, but to rather embrace all green transport technologies brought to this country or invented in South Africa. These accounted for about 15 of 39 views on the choice of green transportation technology, and were raised by TS (2018), BK (2018), TK (2018), PM (2018), City of Cape Town (2018), MM (2018), City of Johannesburg Transport Department (2018), NL (2018), R(2018), MH (2018), Rampersad (2018), Western Cape Provincial Department of Transport and Public Works (2018). Regarding this route, the following principles guided the decision on the choice made:

- Avoidance of a staggered approach, hence avoiding sudden destruction of the status quo;
- Resource scarcity and hence a need to ensure resource efficiency;
- A need to stimulate competition among various green transport technology players;
- A transitional phase, with the neutral route seen as a short-term move and technology picking as a long term strategy. This should give the country some time to adjust while learning about all transport greening technologies and choosing the best option;
- This country's comparative advantage and affordability;
- This country's uniqueness with respect to the socio-economic status, needs, spatial planning, etc.

Some of these principles are evident in the select quotations extracted from personal communication with some of the respondents, and from official reports of a few transport departments at local and provincial spheres of governance as follows:

> We need a transitional phase. That phase involves a basket of activities/ technologies… National Treasury has many times before made it clear that, it is not in the business of giving out money, but rather in the business of collecting money. We therefore need all technologies: CNG, CBG, Biofuels, EVs, Fuel cells, etc. That is the basket (BK, 2018).

A statement that places efficiencies at the forefront of technology neutrality came from a respondent who was passionate about a particular technology, but who nonetheless still shares sentiments on the neutral approach for reasons stated in the quote below:

> For South Africa, it is definitely not going to be one technology, but rather a mix of them. In the short run, do not choose/ pick a technology, but in the long-run, efficiency will be the leading driver with the most efficient technology dominating the space. A combination of the technologies would hence do (TK, 2018).

In its presentation to the Competition Commission Enquiry in June 2018, the Western Cape Provincial Department of Transport and Public Works was quoted as saying that:

> Since 2007, there has been a shift from thinking about mainly BRT to thinking about the full IPTN. An IPTN includes the full multi-modal integrated system: Rail, BRT, conventional bus, minibus taxi, non-motorised transport (Western Cape Provincial Department of Transport and Public Works, 2018).

While demonstrating support for a multi-modal approach, this province however has stated clearly that it only intends supporting the most appropriate mode to enable matching of demand and supply, while meeting quality standards and remaining within financial constraints. It also acknowledges that, in some cases, there has been full replacement of minibus-taxis, where some operators chose to participate in the new system by becoming shareholders. Those that chose not to participate agreed to exit their operation, in exchange for compensation (Western Cape Provincial Department of Transport and Public Works, 2018). In its presentation to the Competition Commission's' in June 2018, the City of Johannesburg Department of Transport (2018) also demonstrated tolerance for multi-modes. The City has identified key public transport corridors that it needs, calling them Strategic Integrated Public Transport Network (SIPTN). These corridors will be operated by rail, BRT, conventional bus and minibus-taxis while recognising a role for demand responsive services (City of Johannesburg, 2018). Over 600 taxis have been removed from operations, with two bus operating companies (Piotrans and Ditsasmaiso) formed with majority shareholding by some of these previously affected minibus taxi operators. Over 400 ex-taxi drivers according to this department, have become bus drivers of these companies.

While NL (2018) indicated no problems with all green transport technologies being promoted in this country, he cautioned that, as a technology taker, South Africa needs infrastructure, regulations, safety, return on investments – aspects, which this respondent argued, are influenced not only at the local level, but also at global levels. In other words, what South Africa ends up with in most cases is influenced by what the major green transportation developers in the world decide to make available to South Africa. This statement relates to the globalisation discussion presented in Chapter 3 and as alluded to in various sub-sections, including sub-section 6.5.3 of this Chapter. It also links well with views presented in the next sub-section, relating to electric vehicles as one of the most preferred choices of technology, chosen by participants in this research.

6.6.2. Electric vehicles

Electric vehicles were second highest in this sub-category with about 9 of 39 views raising them. Issues raised include support for this technology as well as concerns around inadequate infrastructure and policy framework especially around vehicle charging. Most would like to see electric vehicles charged from renewable energy sources hence requiring explicit participation from the Department of Energy as expressed in the following quotation extract:

> EVs, as an example, are not zero emission, which depends on the source of energy. I would therefore like to see better coordination between various departments, e.g. the Department of Energy should play a visible role in the EV industry. They don't seem to be playing much of a role at the present moment in supporting EV roll-out. Yes, there is not enough EVs on the market at the present moment, but when a full blown EV industry takes off in SA the role of this department will need to be very clear. The EVs require electricity to charge, and if the infrastructure is not there yet, how will the process be managed moving forward (TS, 2018).

A choice for electric vehicle technology was based on the premise that a number of past research findings point to this type of technology as the most efficient. Also the international trend which sees the world setting 2030, 2040 and 2050 targets, moving towards vehicle electrification, gives South Africa (a technology taker) no choice but to join in. The vehicle financing arm, WesBank, of one of South Africa's commercial banks (First National Bank), sees the future of passenger vehicle transportation in South Africa following a strict mix of hybrid, fully battery electric and hydrogen fuel cell vehicles as noted in Finlyson (2017). Extracted from Finlyson's presentation, Figure 6.12 depicts future ownership that shows a move away from fleet based on 100% use of fossil fuel based ICE vehicles to hybrids and a fully electric vehicle fleet.

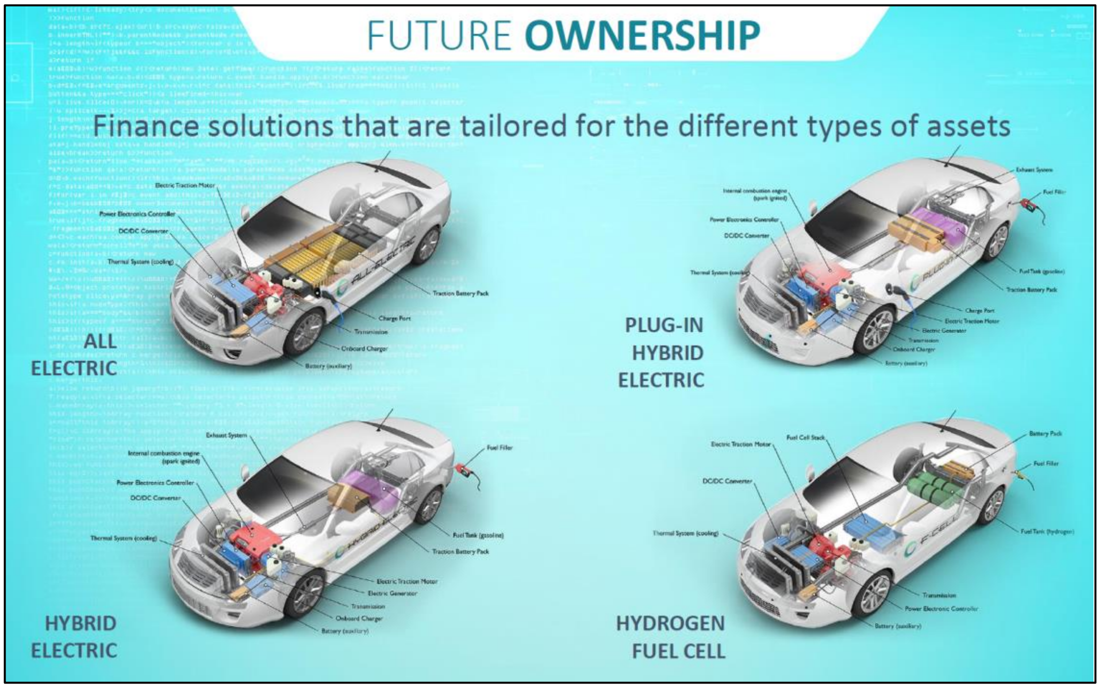

Figure 6.12: Future ownership of vehicle technologies in SA (Finlyson, 2017)

Figure 6.12 portrays a future which this institution believes will be influenced by developments at a global level following the setting of EV targets by various countries of the world including the European Union (one of the major destinations of South Africa's vehicles by value). Also, this country has plenty of renewable energy resources, as well as minerals that are critical to the manufacture of related products such as lithium ion batteries and hydrogen fuel cells. All these, according to the interview respondents in this research, place South Africa on the list of key potential players in the global vehicle electrification industry.

6.6.3. Public transport/modal shift

The issue of public transport or modal shift as a green transport option received the third largest number of views (raised five times). Views relate to shift from road to rail transportation. This promotes transport electrification hence linking well with the discussion in the preceding sub-section on vehicle electrification. These share resemblances in that for vehicles to be truly zero emission, they should be powered from renewable energy sources as argued in Aasness and Odeck (2015) in their study of Norway's electric vehicle roll-out programme success and challenges. Nonetheless, irrespective of the type of fuel used, public transportation is still considered a greener option compared to private car ownership. Views in this sub-section relate to the use of bus rapid transit (BRT) and rendering of support to improve the service provided by self-styled minibus-taxi operators. Public transport is still a green alternative which continues to achieve the goals associated with the desire for a green transport sector. There are issues however, which cannot be ignored. These relate to the competing priorities between various service delivery imperatives, of which transport is just one. While there is general support for public transportation and greening of such, the challenge relates to rushing to greening when the country is still battling with the provision of transport services that meet basic requirements of safety, affordability and accessibility. The main concern as raised by GK (2018) relates to the costs associated with the transition. These include potential job losses from the traditional transportation, automotive and fuel sectors. Obviously a considerable amount of infrastructure has been put in place already, given the time the status quo has been around. While similar sentiments appeared in the study by UNIDO (2016), recommendations in this study proposed a need for South Africa to carefully manage the transition. There will indeed be additional resources needed to bring about new infrastructure to accommodate the transition to new ways of doing things, and these aspects cannot be ignored. Fortunately, the public transportation and the modal shift concepts discussed in this sub-section already feature in this country's policy frameworks, with several examples highlighted in the previous Chapter Five. These modes of transport are also already being utilised, and fit into the green transportation models such as the Avoid, Shift and Improve as described in Chapter Two. As such, the transition fears raised by some respondents may be addressed.

6.6.4. Other green transport technologies

As indicated earlier in this section, other views relate to technology prioritisation/ picking which specify technologies ranging from fuel cell, gas, biofuel, cleaner fuel to renewable energy powered vehicles. The number of issues raised within each of these ranged between one and two. Proponents of cleaner fuels also seem to be pushing for the status quo, supporting continued usage of internal combustion engines. This also those who mentioned the need for continued support of gas and biofuels. All these use the internal combustion engine.

6.7. Conclusion

This chapter presented findings of views raised on how the current policy and legislative regime in South Africa is dealing with issues relating to transport sector greening. This was done based on eight categories, which were informed largely by the literature. It provided views from different actors in the public and private sector institutions, culminating with sections which provided proposals on possible policy direction relating to transport sector greening in this country. Much of what was presented as views was based on real life experiences of those interviewed. It is the author's view that their input reflects not only the views of the institutions they represent, but also their own worldviews.

The author's expectation was that the views of respondents would align with policy positions of their institutions. However, the views of individual respondents appeared to go beyond the mandates or positions of their institutions. It was not uncommon to hear representatives from an economic cluster department strongly leaning towards the environment pillar in their understanding of and description of transport greening in the South African context. The same was true for officials serving mainly in the environment cluster, who had strong views that seemed biased towards the socio-economic pillar. This could be due to their enhanced understanding of sustainable development issues as well as issues on transport greening. Respondents who made these views form part of government policy making processes, either as employees in government or as industry players at local or international levels. While there is no certainty that their views are always factored into decision making processes, but through policy advocacy and through 'rent seeking' tendencies or through the global technological and ideological diaspora alluded to in Chapter Three, it is concluded here that some of these views may contribute to decision making in Government, hence informing future policy direction in transport sector greening. While this chapter and Chapter Five presented results on the status quo in terms of available transport greening policy, regulatory and legislative frameworks and people's views on such frameworks, the following chapter provides a discussion on these results chapters.

CHAPTER SEVEN

DISCUSSION OF RESULTS AND DEVELOPMENT OF A MODEL TO INFORM POLICY DIRECTION

7.1. INTRODUCTION

The research findings presented in Chapters Five and Six addressed the first and second objectives of this research, respectively. This chapter provides the discussion on findings for the third objective: *Discussion of findings, comparing and contrasting South Africa with the world, making recommendations and development of a model to inform policy direction.* As this chapter compares and contrasts South Africa with the world, it will rely on globalisation theories introduced in Chapter Three. The core versus periphery relationship, a phenomenon described in Robinson (2007) features prominently in the discussions in this chapter. South Africa's adoption of the developed world transport greening technologies and ideologies demonstrates the influence of the latter on the former.

The current chapter provides the discussion on results presented in the previous Chapters Five and Six. It is divided into five sub-sections, including the current section. This is followed by the second sub-section which provides comparison of South African policy, regulatory and legislative frameworks (Chapter Five) with equivalent frameworks in a select number of countries at global level. Thirdly, the chapter compares South African perspectives (Chapter Six) with world perspectives. Information on global experiences and approaches to greener transportation was presented in Chapter Two, mainly in the form of a literature review. This information is used in this chapter to benchmark South Africa against the other countries that have adopted greener transportation technologies, associated policies and incentive mechanisms. The six major categories used in the benchmark process arose from the literature and include cleaner fuels, fuel economy, alternative fuels, modal shift and non-motorised transport.

Results on South Africa's experiences in the form of policy framework status quo, as well as views on the country's green transportation regime, are presented in Chapters Five and Six respectively. So, the discussion in this chapter is primarily based on results in these two chapters and in Chapter Two. The fourth sub-section of this chapter makes recommendations, which include a model to inform policy direction and the final sub-section provides concluding remarks.

7.2. COMPARISON OF SOUTH AFRICA'S POLICY FRAMEWORKS WITH GLOBAL POLICY FRAMEWORKS

This section compares and contrasts South Africa's transport greening policies and legislative frameworks against relative frameworks adopted in other parts of the world. The globalisation theories introduced in Chapter Three feature prominently in the discussion. Most countries that have embraced sustainable transport practices are located in the European Union, North America, Latin America and Asia-Pacific regions, which are all classified as core in the world map presented by Wu (2016) in Chapter Three. This is a map that is based on the World Systems Theories developed by sociologist Emmanuel Wallerstein (Robinson, 2007; Wu, 2016; Hurst, 2018). On this map, South Africa is depicted as a semi-periphery country. If one is to follow the arguments presented by Robinson (2007) on globalisation theories, one may begin to understand the consequences of South Africa falling into the semi-periphery category. It means this country becomes a taker of not only technology, but also the ideologies, culture, politics, policies and many more issues described in these theories. This is explained by the fact that, in most cases, South Africa is about 10-15 years behind these countries in terms of greening technologies or policy adoption.

While South Africa has made progress in the development of programmes and policy frameworks as depicted in Figure 5.8 of Chapter Five, most progress is fairly recent and at times, is still in progress. For example, the National Green Transport Strategy approved by Cabinet in 2018/2019, is now beginning to feature in the country's policy space.

Purely driven by innovation, literature reveals that the early forms of transport sector greening facilitated in the core (developed) countries involved the manufacturing and use of electric vehicles as early as 1801–1850 (International Energy Agency, 2013). Later developments brought about by the 1970s oil and energy crisis further encouraged use of alternative fuels and vehicles (Lott, 2016; Miller and Facanha, 2014; Nesbit et al., 2016). This was done through the use of legislative and policy levers which, as discussed in this section, have potential to assist South Africa's transition to an improved and greener transportation era. So, transport greening is not something new in the world, only the drivers seem to have evolved. Another issue worth mentioning here is that South Africa uses the phrase “green transport” more frequently than and interchangeably with commonly used phrases like eco-mobility, sustainable transport and sustainable mobility. South Africa's relationship with the world in terms of transport greening policy frameworks is discussed in the following sub-sections.

7.2.1. Fuel quality improvement (as a local air quality driver)

In 2006 South Africa adopted emission standards resembling those developed in the European Union (EU) which had started the process as early as 1992. Nonetheless, the current fuel quality (Clean Fuel 1) used in South Africa is deemed compatible with those permissible in the EU's so-called Euro 2 standard (Department of Energy, 2011). This appears to be a direct policy simulation. While these two regions have developed related standards, the regulated parameters differ slightly. While Euro 2 includes Carbon Monoxide (CO), Hydrocarbons (HC), Nitrogen Oxides (NOx) and Particulate Matter (PM), the main focus in South Africa's standard is related to the abolishment of lead in petrol and sulphur reduction in diesel. Since South Africa is still trapped at Euro 2 equivalent fuels, migration to Euro 5-based fuels, requires local oil refineries to upgrade. It is also stated that South Africa's still pending clean fuel 2 policies will be equivalent to Euro 5 standard (Department of Energy, 2011). A closer look at Euro 5 parameters gives Total Hydrocarbons (THC) and NMHC as regulated parameters, in addition to those under Euro 2 standard. South Africa's parameters under the Clean Fuels 2 programme however include further reduction of sulphur content in both petrol and diesel.

The similarity between Euro 5 and CF2, according to Miller (2019), is in terms of fuel specifications for such parameters as sulphur, aromatics, benzene, olefins, manganese, PAH and cetane number in both petrol and diesel. The major difference between the two standards is with respect to sulphur content in diesel, where South Africa specifies a more stringent level of 10mg/kg (ppm) compared to Euro 5's level of 50mg/kg (ppm). Another noticeable difference is with respect to the levels of manganese (in petrol) where in the case of South Africa's specifications, manganese is undetectable, with Euro 5 standards setting this parameter at 2mg/litre. The claim by the Department of Energy (2011) that South Africa's fuel quality standards are comparable with the European standards was therefore confusing, given these differences pointed out in the literature. Nonetheless, even if South Africa's CF2 is approved and becomes policy, this country will still be far behind its EU counterparts given that Euro 5 came into effect as early as 2009 in the European Union (Delphi, 2016/2017).

All these parameters, whether in Europe or in South Africa, were designed to target pollution, implying that the early forms of transport greening initiatives (excluding EVs in the early 1800) in both regions were driven by the desire to curb atmospheric pollution as a result of tail pipe emissions. Table 7.1 shows differences between South Africa's and the world's emission standards. It shows policy positions which, it is argued in this chapter, helped to bring about the latest and current forms of green transportation such as alternative fuels and vehicles in the developed regions.

Table 7.1: Clean fuel policies (source: Delphi, 2016/2017; DoE, 2011 and DEA, 2009)

<table>
<tr><th>EUROPEAN UNION</th><th>SOUTH AFRICA</th></tr>
<tr><td>EU Emission Standards - 2003/17/EC - Euro 2 - CO, HC, NOx and PM
Standards -70/156/EC - Euro 5 - CO; NOx; HC, PM, THC; NMHC</td><td>Fuel specifications and standards – the Cleaner fuels 1 – lead abolishment in petrol and reduction in diesel sulphur content 3000ppm-500ppm and 50ppm, respectively – international influence. SA’s current fuel deemed to subscribe to Euro 2 requirements.

Cleaner fuels 2 – reduce sulphur to 10ppm in both petrol and diesel. Also benzene and aromatics to levels equivalent to Euro 5. Intends to pave way for cleaner vehicle techs such as catalytic converters and diesel particulate filters.

Instead South Africa has a National Ambient Air Quality Standard, regulating parameters: SO_2, NO_2, PM10, O_3, Benzene (C6H6), Pb and CO.</td></tr>
<tr><td colspan="2"><u>North-America</u>
US Federal (EPA Tier II standards, 2004-2007) and Tie III Standards (2017-2025). Parameters- NMOG, NOx, PM, CO, HCHO. California has its own standards in addition to the Federal standards</td></tr>
<tr><td colspan="2"><u>BRICS Member Countries</u>
China 5 Standard (GB18352.5-2913, replacing GB 18352.3-2005 with effect from 1 January 2018. So parameters include NOx, PM, CO and HC and PN (particulate number)
Brazil- Proconve L5-L7- Parameters- NMHC, CO, NOx, HCHO, PM
Russia- Euro 5 from January 2016
India- Euro 5 from April 2017- April 2019</td></tr>
</table>

It looks like most countries whether in Latin America, Europe, Asia-Pacific or Africa, including BRICS member countries, have adopted the EU emission standards. A few countries, notably Canada, adopted USA Tier III standards (Delphi, 2016/2017). Chile adopted hybrid systems with the US Tier II Bin 5 standard adopted simultaneously with the Euro 5 standard. New Zealand also provides options for compliance with the Euro 5 or US and Japanese standards (Delphi, 2016/2017). The International Council on Clean Transportation (2015) also noted that China 5/V emission standards are more demanding than those set under the European 5/V standards. One example is a requirement for heavy-duty vehicles driven on Chinese urban roads to undergo testing on the World Harmonized Transient Cycle (WHTC). This is required in order to prevent excess emission of Nitrogen Oxides (NOx). The exception is limits on particulate matter for conventional fuels, where Chinese limits are comparatively less stringent than the European limits. Like its BRICS counterparts, South Africa seems to have aspired to complying with EU emissions standards by trying to control the following parameters for petrol: sulphur content, benzene content, aromatics, olefins and volatility. South Africa is often compared with countries in Europe, where transport greening policy and legislative frameworks are deemed a particular form of state intervention, intended to internalise the negative consequences associated with the conventional transportation sector as discussed in the European Commission (2019) report. This report noted that:

> Without policy intervention, the external and infrastructure costs of transport are generally not borne by the transport users and hence not taken into account when they make a transport decision. By internalising the external and infrastructure costs (i.e. making these costs part of the decision making process) the efficiency of the transport system can be increased (European Commission, 2019).

The need for the South African Government to intervene in this area was brought about by deficiencies in the traditional approaches to transportation, which could be associated with a free-market enterprise system. South Africa's attempt to correct such market failures involved the adoption of EU standards, something that tells a story about the impact of globalisation in greening a developing country's transport industry. Using arguments from writers such as Robinson (2007), Wu (2016), Hurst (2018) and Major (2013), it is argued here that globalisation plays a particular role in influencing the manner governments in developing countries conduct their business. South Africa is not alone as most countries (some in the developing regions) shown in Table 7.1, as reported in Delphi (2016/2017), have adopted either European or American Standards to address tail pipe emissions from their automobile road fleet. This means that countries in the developed world have set the standard in terms of leading the direction and influencing transport greening policy thinking of countries in the developing regions. More depth on this globalisation phenomenon is provided in the next sub-section. This section attempts to explain reasons behind South Africa's choice for EU standards as opposed to selecting USA-based standards, or developing its own standards.

7.2.2. Is South Africa's semi-periphery status a key reason for adopting Euro standards?

While a former colony of countries of European origin, South Africa is also a major trading partner with some of these countries when it comes to the automobiles, and this could partly explain reasons behind choosing EU standards over US standards. To highlight this, in Chapter Five it was revealed that a large number of under 1000cc vehicles from the EU, flooded the South African market in recent years, partly due to the 2009 Trade, Development and Cooperation Agreement (TDCA) as described in the Official Journal of the European Communities (1999). It can therefore be argued that Europe has an influence on the transportation affairs of this country. With South Africa being part of this "one" global system, explainable through a systems approach to thinking, this chapter argues that South Africa's leaning towards these international policy positions, attests to the globalisation theoretical propositions introduced in Chapter Three. It attests to the World Systems Theories and Global Capitalism Theories, where authors like Robinson (2007) described the world as a capitalist economy that emerged many years ago in West Europe. It is an economy, which this writer believed:

> … had expanded outward, absorbing in the process all existing mini-systems and world-empires and establishing market and production networks that eventually brought all peoples around the world into its logic and into a single worldwide structure (Robinson, 2007: 128-129).

If many countries as noted above, including South Africa, adopted EU Emission Standards, what does this tell the reader about Robinson's statement? It simply gives some indication of the world order and the reasoning behind these standards. It could mean, simply expansion of policies in a manner that extends control over the semi-periphery countries described in the world map provided by Wu (2010) in Chapter Three. South Africa's tendency also seems to fit into Robertson's (1995) introduced concept of *"glocalisation".* That is to say, instead of taking everything from the EU standards, South Africa rather prioritised certain pollutant parameters in its fuel cleaning specifications, in a manner that looks like adoption of the global outlook to local conditions described in Robertson (1995). Even though this country has done this, the argument still stands that the EU has had a larger influence in this country's adoption of emission standards, given the small amount of adjustments South Africa has made to these standards. As noted in Miller (2019), Euro 5 and CF2 are almost identical, with the exception being sulphur content in diesel and manganese in petrol, where South Africa's standards are stricter than the EU standards. With Euro 2-like standards successfully adopted in South Africa as early as 2006 (Government Gazette No. 28958 of 2006), the next step calls for resolving the issue of Clean Fuels 2 through rendering support to refineries to start producing the right fuels equivalent to Euro 5 and 6 standards. Or this country will be stuck with old vehicle technologies, while the world is moving ahead towards newer and less polluting vehicle technologies.

From the brief comparison of South Africa with the rest of the world in this sub-section, some resemblance is undeniably noted in terms of efforts to improve vehicular emissions, by targeting the quality of fuels used in the automobiles. While minor differences exist between the standards adopted, the major difference is that South Africa is too far behind, especially compared with the European Union. Comparison in terms of measures adopted to improve the efficiency of vehicles used, provides a dissimilar picture as discussed in the following sub-section addressing fuel economy.

7.2.3. Vehicle fuel economy (as a climate change driver)

The world is already far ahead of South Africa with the use of cleaner fuels as discussed in the previous section. While major transport greening countries including the EU member countries, the USA, Japan and China, have set CO_2/ fuel economy targets for new passenger cars, South Africa is once again lagging behind. The South African Bureau of Standards (2006) developed this country's first fuel economy standard (SANS 20101), which was later welcomed and implemented by the automotive industry, through encouragement by their representative body, NAAMSA. This signalled the country's initial efforts towards improving fuel efficiency of vehicles used on the roads. However, this standard is only an eco-label, designed to raise consumer awareness. It gives prospective consumers of new automobiles a chance to compare various vehicle models in terms of their performance when it comes to fuel consumption. Similar to what South Africa has done, the European Union Directive 1999/94/EC of 1999, developed an ecolabel for EU countries as described in the Official Journal of the European Union (1999). The purpose of this Directive as described in its Article 1 was to:

> … ensure that information relating to the fuel economy and CO_2 emissions of new passenger cars offered for sale or lease in the Community is made available to consumers in order to enable consumers to make an informed choice (Official Journal of the European Union, 1999).

According to Article 3 of this Directive, member states were required to ensure that a label on fuel economy and CO_2 emissions, is attached to or displayed, in a clearly visible manner, near each new passenger car model at the point of sale. Developed about seven years apart, both the EU and the South African eco-labels are described and compared in Table 7.2

Table 7.2: Fuel economy policy comparison (by author)

THE WORLD	SOUTH AFRICA
Eco-label: Directive 1999/94/EC of the European Parliament and the Council of 13 December 1999- regarding availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger car.	RSA fuel economy and carbon dioxide emission ecolabel - SANS 20101: 2006- Labelling to indicate fuel economy in litres per hundred kilometres (l/100km) and carbon dioxide (CO_2) emissions in grams per hundred kilometres (g/km).
Obligation/mandate: The EU Directive - Regulation No 443/2009 sets an average CO_2 emissions target for new passenger cars of 130 grams per kilometre, gradually being phased in to reach about 95 grams per kilometre to 2021. This translates to about 4.09litre/100km. USA (93 g/km for 2025)= 4.008l/100km, Japan (105 g/km by 2020)= 4.5l/100km, and China (117 g/km by 2020)=5.04l/100km	No fuel economy targets – the standard mentioned above only requires vehicle emissions testing and eco labelling, without imposing any restraints, except the environmental (CO_2) tax on new vehicle purchase.

Indeed, South Africa's fuel economy eco-label is not targeted at producers of such vehicles, but rather at consumers, and hence provides no incentives for innovative ideas on the part of automobile OEMs present in South Africa. This is unlike in the EU, US, Japan and China which the International Council on Clean Transportation (2014), Nesbit et al. (2016) and Miller and Facanha (2014) regard as having set real fuel economy targets and implementation timelines in their fuel economy standards. Table 7.2 illustrates how far the EU and other developed world countries such as Japan and the United States of America, have gone beyond the mere eco-label. Through the use of mandates, these countries have set real fuel economy targets, to be implemented in phases. China has also joined this bandwagon, by also developing standards that have real fuel economy targets.

The EU's standard, developed in 2009 as noted in the Official Journal of the European Union (2009), is not simply an eco-label like its predecessor developed ten years earlier in 1999. Instead, it set emission performance standards for new passenger cars registered in the EU community, hence forming part of this region's integrated approach to reducing carbon dioxide emissions from light-duty vehicles while ensuring the proper functioning of the internal market. From the CO_2 emission targets in the EU, USA, Japan and China as shown in Table 7.2, the vehicle fuel efficiencies for new passenger vehicles in these regions was calculated as shown in Figure 7.1. The conversion of CO_2 values to vehicle fuel consumption figures was calculated using the litre/100km conversion factor of 0.0431034, obtained from Unit Juggler (2019). South Africa's and the EU's 2015 consumption figures are based on CO_2 emission figures from a study conducted by Posada (2018) of the International Council on Clean Transportation (ICCT). South Africa's comparison with these regions shows that this country is indeed still far behind when it comes to fuel economy. A model to model comparison of these vehicles can be found in Chapter One, where models in the EU far outperform similar models in South Africa (e.g. Toyota) as revealed in Posada (2018). So, this highlights the impact of the EU Directive referred to in Table 7.2, which set a target for fuel economy in this region, forcing vehicle manufacturers to comply. With South Africa having not set any real fuel economy targets as compared to its EU, US, Japan and China counterparts, the possibility for any further progression towards this area is questionable.

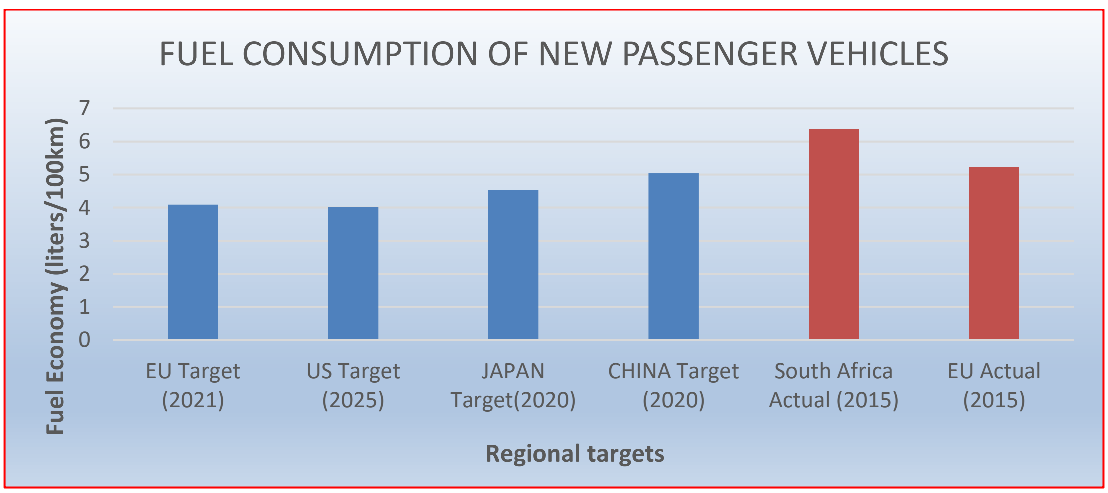

Figure 7.1: Comparison of South Africa's and world vehicle efficiencies (by author from ICCT, 2014 and Posada, 2018)

International organisations such as the ICCT (alluded to above) have made attempts to lure South Africa into setting fuel economy targets. As noted, this forms part of the Global Fuel Economy Initiative (GFEI) driven in partnership between the International Energy Agency (IEA), the United Nations Environment Programme (UNEP), the International Transport Forum of the OECD (ITF), the International Council on Clean Transportation (ICCT), the Institute for Transportation Studies at UC Davis, and the FIA Foundation (Posada, 2018). This again triggers the same political economy argument made in the previous sub-section. All these are global institutions that seem to be concerned about the performance of vehicles used on South Africa's roads. This raises questions about the rationale for such concerns, hence reintroducing the earlier debate, where Gerau (2012) described core countries, especially the European Union, as directional leaders, for externalising their environmental protectionist rules and values to developing nations. This is not to argue that South Africa does not need advice and opinions from international experts in the field, as this country has indicated (when it committed to reducing GHGs by 34% by 2020 and by 42% by 2025), that such commitment is conditional. It is depends on the core countries' ability to render developing nations, various forms of support including capacity-building (Department of Environmental Affairs, 2018). Perhaps this is one of the reasons why these international institutions decided to intervene. It must also be noted that the developed nations do business with South Africa, and the setting up of fuel economy standards would mean their ability to expand the market share for their fuel efficient vehicles.

As was alluded to in Chapter Five, the European Union has, through zero tariffs on under 1000cc vehicles, successfully enhanced the market for this small segment of automobiles in South Africa as depicted in Figure 5.5 developed from data sourced from Quantec (2018). It is argued here that the introduction of fuel economy standards that set real targets in South Africa, will enhance the position of other countries to introduce more fuel efficient vehicles into the South African economy. Coupled with improvements in the quality of fuels or the introduction of alternative greener fuels in this country, this will in turn contribute to the reduction of GHG emissions and atmospheric pollution, while also giving South Africans a chance to save purchase and operation costs from using vehicles with improved efficiencies. It should be recalled from SARS (2020) that, as part of the carbon tax, hefty fines of R120 per g/km CO_2 emissions are imposed on vehicles that exceeded the 95g/km CO_2 emission threshold. For goods vehicles, with CO_2 emissions exceeding 175g/km, a hefty penalty of R160 per gram / kilometre CO_2 emissions is imposed on this category. Based on the arguments by Radcliffe (2017), the levies on fuel inefficient vehicles, should in principle increase their purchase costs, hence discouraging their consumption. Consumer behaviour is however a complicated phenomenon, with the success of this levy questioned by such writers as Vosper and Mercure

(2016). Since the costs of the levy are borne by the consumer, this only provides a demand measure which again does not seem to have much influence on the supply side, since producers simply pass the costs onto the consumers. This is unlike the Chinese and Californian NEV and ZEV schemes, which either praise consumers for introducing more energy efficient vehicles or punish them for not doing so, as argued in Ou et al. (2019) and Hardman et al. (2018). These kinds of schemes are crucial to the arguments presented in this section; they have assisted these regions, especially California and other states to help roll out more energy efficient vehicles into their markets.

The success of a fuel economy programme will however depend on many other factors including driver behaviour, vehicle maintenance and price of fuels over time. The overall impact on the economy will therefore need to be analysed separately, with the following sub-section only examining the manner South Africa has benefitted from stringent global emission mandates discussed in the preceding sub-sections.

7.2.4. South Africa reaping the benefits from strict global emission mandates

As revealed in Posada (2018), South Africa's vehicle fleet is less green compared to fleets in countries that have set strict emission rules and targets. Data from the country's 2016 Export Manual shows that South Africa exported a relatively large number of vehicles to the EU, especially in the years 2013-2015 (NAAMSA, 2016). As shown in Table 7.2 above, by law these vehicles have to be clean and compliant with EU standards. So South Africa has the capacity to manufacture Euro 5 compliant vehicles for the global market, while its own fleet utilises dirty fuels that are not compliant with Euro 5. This means that South Africa's continuation with dirty fuels does not seem to be due to the country's inability to produce suitable vehicles, but rather the country's incapacity to arrive at informed policy decisions about its refinery upgrades to produce the right quality of fuels as presented in Chapter Five. There is therefore a fuel quality issue rather than a vehicle issue. Posada (2018) arrived at a different conclusion, placing the blame on the lack of access to high efficiency technologies and vehicles as driving the gap between South Africa and EU vehicle efficiencies. In this research, it is argued however that what drives the gap between these two regions is rather lack of appropriate fuels in South Africa as opposed to the lack of appropriate vehicles. The stagnant Clean Fuel 2 programme discussed in Chapter Five was meant to close this gap: how can a country manufacture high efficiency vehicles for its domestic market when the fuel produced is not of the appropriate standard measured by Euro 5?

Besides vehicle exports, international automotive makers also source catalytic converters from South Africa. With strict emission standards in these regions coupled with South Africa's competitive advantage when it comes to the platinum group of metals (PGMs), this country has reaped benefits by tapping into the vehicle export market (TK, 2018). The following statement infers that EU emission standards have created a market for South Africa's catalytic converters: 'The EU Standards – about 44% demand on platinum – was brought about by these standards. We would not have auto catalytic converters if it was not for the EU standards.' (TK, 2018).

Further to policy provisions targeting fuel quality and fuel economy in the developed world, these policy frameworks seem to have done great work in encouraging research, development and introduction of greener fuels and vehicles, however more in these countries than in South Africa. This is discussed in the following sub-section.

7.2.5. Alternative fuels and vehicle policy frameworks

The 2020 target in Europe for 10% of transport fuels to be derived from renewables seems to be based on the EU Directive 2009/28/EC (RED) having developed the incentives that helped stimulate transport greening initiatives in this region (Belincanta et al., 2016). Similar to the EU Directive, the three major legislative frameworks in the United States, namely the Energy Policy Act (EPAct of 2005), the American Clean Energy and Security Act of 2009 and the Energy Improvement and Extension Act of 2008 make provisions that promote green automobile technologies such as electric vehicles, biofuel and compressed gas powered vehicles (Zhang et al., 2014). The only legislative framework in South Africa that specifically promotes alternative fuels is the Biofuels Blending Regulations as published by the Department of Energy (DoE, 2012). These regulations set the national requirement of 2% and 5% blending of bioethanol with conventional petrol and biodiesel with conventional diesel, respectively. Nonetheless, while this regulation came into effect in 2015 (as discussed in Chapter Five), the implementation was halted due to reasons associated with a need to arrive at appropriate incentive mechanisms (DoE, 2012).

Table 7.3 compares key features of the world versus South Africa with respect to alternative fuel and alternative vehicle policy support tools. Regarding the use of alternative fuels as well as general promotion of alternative vehicles including electric vehicles and hybrid vehicles, no specific policy or legislative provisions have been designed to actively promote these technologies. Like in South Africa, the legislative frameworks in Latin America, notably in Brazil and in other Asia-Pacific countries (excluding China and Japan), but including India, Thailand, Philippines and Indonesia, seem to have placed more emphasis on biofuel legislative development as discussed in ERIA (2014) and in Belincanta et al. (2016). A similar trend in other African countries including Zimbabwe, Mozambique, Malawi was observed in the research by Gheewala et al. (2013). This could be due to many perceived benefits of this technology as mentioned by various authors in Chapter Two. One such benefit relates to reduced dependence on oil imports as well as improvements in the socio-economic conditions of the country's citizens, including the creation of employment opportunities (Gheewala et al., 2013).

Table 7.3: Alternative fuel and vehicle targeting policies (by author from DoE, 2012; Zhang et al., 2014; EPAct, 2005; American Clean Energy and Security Act of 2009; ERIA, 2014 and Belincanta et al., 2016)

Target technology	World	South Africa
Biofuels, CNG, electricity and hydrogen fuel cells	**Europe -** in Europe, the EU Directive 2009/28/EC (RED) – a requirement that, by 2020, about 10% of energy for the transport sector should not be from fossil fuels. There is also Directive 2014/94/EU which encouraged member states to come up with EV rollout targets as well as targets for other alternative fuels and vehicles. **North-America -** In the US three main ones, the Energy Policy Act (EPAct of 2005), The American Clean Energy and Security Act of 2009 and the Energy Improvement and Extension Act of 2008, have provisions specific to transportation and domestic fuel security and alternative fuels and vehicles. **Asia-Pacific -** In Philippines, the Biofuels Act of 2006. In Indonesia, the National Energy Policy of 2006 stipulating blending guidelines of 2% biofuel mix increasing to 5% by 2016. In 2006 India mandated 5% blending of ethanol with petrol. Japan - Next Generation Automotive Strategy 2010, Automotive and Industrial Strategy 2014 - sets between 50-70% target of market share of cleaner automobiles (PHEVs, HEVs, FCVs-3%, EVs, Clean Diesel) by 2030. **Latin-America -** Brazil's "RenovaBio" law aimed to stimulate biofuels and biogas production.	Biofuel Blending Regulations – 2% and 5% bioethanol and biodiesel respectively – no target date, only commencement date of 1 October 2015 No regulation declaring CNG as transport fuel nor prohibiting its use, the same applies with use of gas powered vehicles No regulation singling out electricity as transport fuel nor prohibiting its use, the same applies with use of electric vehicles No regulation targeting the use of hydrogen fuel cells nor prohibition of its use. Yet, South Africa is well endowed with platinum, which exceeds 70% of the globally known platinum resources.

The rapid expansion of biofuels in Asia, according to the International Resources Group (2009), brought with it several challenges on the part of decision-making institutions. This institution as well as UNCTAD (2014) advised that policy priorities should therefore encourage the adoption of approaches that contribute to the enhancement of poor people's socio-economic status, targeting mainly those people serving in the agricultural sector located in rural areas, while also improving environmental protection. In a report by the International Energy Agency (2019), Africa and Asia account for more than half of global bioenergy demand. Concerns for food security however have driven Southern African countries to avoid feedstock that competes with food (Charis, et al., 2018). The rationale in developing countries hence seems to differ from the rationale in EU, US and other developed Asia-Pacific countries like Japan and Australia. The drivers in the developed countries are mainly linked to CO_2 emissions reduction and clean energy supply (Nesbit et al, 2016). This excludes the US, which according to Banister, Pucher and Lee-Gosselin (2007), as well as Baran et al. (2013), was initially driven by the desire to improve air quality and to maintain energy security. The United States had started taking action as early as the 1960s to introduce formal requirements for use of catalytic converters in the new automobiles (Banister et al., 2007). The idea was to curb the emission of harmful gases and improve the quality of ambient air. There are thus considerable differences between the developed countries themselves. From the political economy debates provided in sub-section 7.2.2, the EU's stance probably explains why South Africa is perceived in this research to be advocating so strongly for greenhouse gas (GHG) matters. Policy frameworks such as the Green Transport Strategy as well as the transport flagship projects all have a bias towards mitigating the effects of climate change.

The discussion in the preceding sub-sections demonstrates South Africa's uniqueness when compared with other global players in terms of social, political, economic and environmental conditions. It is a country with many socio-economic challenges including the high rate of total unemployment recorded at 26.7% in the first quarter of 2018, and youth unemployment at over 38% in the same quarter (Stats SA, 2018). South Africa is therefore a country which one can argue is still trapped in the "reconstruction phase", following the long history of colonialism which along with the apartheid system, left a planning legacy that is still felt today from a transportation perspective. Being trapped in a spatial planning legacy means that more resources have to be channelled towards improved transport services and infrastructural projects to redress the past. This, coupled with high rates of unemployment, make these the most pressing needs which, in turn, exert pressure on the decision makers who are expected to prioritise them. As noted in National Treasury (2019), total expenditure on transport and logistics infrastructure alone in the period 2015-2018, has been the highest compared to spending on other services such as health, energy, education and others. These are Strategic Infrastructure (SIPs) projects labelled as SIP7, SIP6 and SIP8, as discussed in Chapter Five from reports by the Department of Economic Development (2017). National Treasury (2019) allocated these projects larger budgets compared to their SIP counterparts in the period 2015 to 2020. These have brought many urban and transport related infrastructural projects to fruition, including the bus rapid transit (BRT) system as well as the railway network upgrades. Despite certain challenges and criticisms as alluded to in previous chapters, these projects are in line with the green transportation pyramid and the Avoid-Shift-Improve models presented in Urban Hub (2020) and GIZ (2016), respectively.

The greening mandate of South Africa's legislative framework emanates from the country's Constitution introduced in Chapter Five, especially the Bill of Rights. This has informed environmental thinking in subsequent legislative provisions including those relating to the transport sector. With a young democracy dating back to the early 1990s, South Africa is far behind in a number of transport greening initiatives including cleaner fuel, fuel economy as discussed in the previous sub-section. To a certain extent, this makes it hard to compare South Africa with the developed countries. South Africa is nonetheless a global player that has established trading partnerships with counterparts in the developed world as noted in the Export Manual by NAAMSA (2016). Furthermore, this country is a gateway to Africa, hence presenting many opportunities for local manufacturing and exporting of green transportation technologies to the region. This sub-section has benchmarked South Africa against the world. What has been learned globally has been that a policy/legislative framework alone means nothing if not accompanied by appropriate mechanisms to support the mandated requirements. These mechanisms include a combination of demand pull measures such as subsidies, tax breaks, preferential registration fees as discussed in various literature documents including Ou et al. (2019), Hardman et al. (2018), Yingqun (2017), Forbes Media LLC (2017) and Centre for Climate and Energy Solutions (2019). These documents also highlighted examples of policy shifts away for demand-pull towards supply pull measures such as China's NEV and California's ZEV credits. Also, non-financial measures in the form of exclusive access to specific lanes such as those applied in Norway, have often been used successfully. South Africa's comparison with the world in terms of these incentive support programmes, is the subject of discussion in the following sub-section.

7.2.6. Green transport incentive mechanisms: South Africa versus the world

The review of literature in this research showed how countries have experimented/ adopted different types of technologies. Some technologies have received more priority than others, e.g. in Norway, there are various incentives to encourage e-mobility (Partnership on Sustainable Low Carbon Transport, 2018: 3). What seems evident in this case is that technology roll-out was facilitated through the use of demand and supply side financial and non-financial measures. It seems in these countries, most notably in the EU, technology choice is dictated by its ability to assist with achievement of mandatory CO_2 emissions targets. It is therefore not uncommon in these regions to find a 'basket' of green vehicle technologies including electric vehicles, biofuel powered vehicles and natural and liquefied gas powered vehicles, all being promoted because of their perceived role in curbing GHG emissions. The same could be said about South Africa, where though small in numbers, electric vehicles, compressed gas and biofuel powered vehicles are part of the fleet. There has been no specific technology selection in South Africa, with the exception being biofuels actively promoted through the mandatory blending regulations alluded to above and discussed in detail in Chapter Five. In addition to the regulations, the next step has been the development of a regulatory framework to incentivise biofuels, which was approved in 2019 and promulgated in the Government Gazette (Gazette No. 43003 of February 2020). Targeting biofuel penetration of 4.5% volume per volume (v/v) to the national transport fuel pool, this will be funded from the fuel levy, ranging between 3.5 and 4.0 cents/ litre. Targeting farmers of first generation biofuels, as well as producers of first generation biofuels, these will be funded from revenue collected from users of conventional petrol and diesel through the fuel levy charged at the pump (Gazette No. 43003 of February 2020). In implementing this regulatory framework, it is argued here that South Africa can learn much from biofuel-experienced players like Brazil.

While the promotion of alternative fuels in Brazil has contributed to the biofuel industry here, it has however occurred at the expense of revenue collection, with the forgone revenue, as noted in Soto and Teixeira (20160 and Cavalcanti et al. (2011), likely to occur with more addition of flexi-fuel vehicles into the country's road fleet. Notwithstanding this, Government's 'RenovaBio' law introduced in Chapter Two, enhanced the support programme as a way of continuing to promote biofuel production and uptake. These came in different forms, with Government providing fiscal incentives and setting targets for the reduction of emissions (Addington, 2017). With this programme, Addington noted that Carbon Intensity (CI) ratings are assigned to transportation fuels, with the ratings based on each biofuel producer's production processes and the extent to which they reduce greenhouse gas emissions. This is closely linked to the Paris Agreement (COP21); this country committed to reducing GHGs by 43% from 2005 levels. The RenovaBio programme could incentivise fuel distributors to boost hydrous ethanol sales at the expense of gasoline sales in order to meet greenhouse gas reduction goals. Rather than depending primarily on hydrous ethanol's price relative to gasoline's price, this programme, according to Addington (2017), will provide additional motivation for drivers of flexi-fuel vehicles to use this ethanol blend rather than pure fossil-based gasoline.

The resemblance between Brazil's and South Africa's programmes relate to their punishment of fossil-derived petroleum products, with South Africa adding a fuel levy, which in turn, will fund biofuel production including feedstock farming. Brazil's programme, much older and well established, does the same, making fossil-based gasoline less attractive than anhydrous ethanol. But Brazil has a larger national blending ratio of 27% whereas South Africa's national blending ratio is limited to 4.5%. No large scale commercial producers currently exist in South Africa, with many potential feedstock suppliers already present. The sugar industry could be a source of feedstock. This industry is already experiencing serious competition challenges, which may force it to diversify product streams, to include biofuels. Sugarcane, sugar beet, soy bean, sorghum are some of the bio-ethanol feed-stocks supported in the country's Biofuel Draft Position Paper (Department of Energy, 2014). The type and source of feedstock is, however, a highly contested issue in South Africa's biofuel debates, with the use of feedstock that competes with food, specifically maize, completely forbidden (Department of Energy, 2014).

Table 7.4 shows a series of measures comparing South Africa with the rest of the world in terms of the provision of transport greening incentive mechanisms/promotions. Based on the analysis of information presented in Chapters Two and Five, South Africa does not differ much from other countries having developed incentive support mechanisms that provide a basket of possibilities. North America, Asia-Pacific and European Union regions have incentives each targeting electric vehicles, compressed / liquefied natural gas and biofuel vehicles, respectively. This is true for Latin American countries too, where biofuel and CNG incentives are also in place. Success in these regions came about as a result of specific incentive mechanisms to promote these transport greening developments. What Table 7.4 shows is a combination of demand and supply targeting incentive tools, which define what is available to willing investors and consumers of green transport products and components in South Africa, compared to what is available internationally. This table attempts to point out that South Africa has a series of financial and non-financial support measures, and thus the country cannot be completely discredited. Stringent conditions and lack of provision of support are evident, however, such as in the requirement contained in the Volume Assembly Allowance which stipulates a threshold of 50 000 units before manufacturers can qualify for the production incentives (**the dti**, 2017). With imported electric vehicles taxed a high import tariff of 25%, this policy position probably actively discourages transport greening efforts.

Furthermore, the unregulated nature of CNG for use in transport, as discussed in Chapter Five, creates policy uncertainties, with potential to deter investments in the sector. The regulated prices according to the Department of Energy (2018) are only for the final product at the filling station pump. From the media statement of the Central Energy Fund (CEF, 2017 and 2018), CNG does not appear on the list of fuel products. This type of policy stance seems to be the kind of environment the industry prefers compared to the command and control approaches which Cole and Grossman (1999) equate to 'Soviet-style' regulation and 'socialist central planning'.

Table 7.4: Incentive Schemes – South Africa versus the world (by author based on literature and policy reviewed in Chapters Two and Five)

South Africa Green Transport Financial Incentives		The World Green Transport Financial Incentives	
Demand side incentive	Supply side incentive	Demand side financial incentives (individual or company users)	Supply side financial incentives (manufacturers or producers)
• Relaxed trade on green/alternative automotive fuels such as biodiesel, natural gas and hydrogen • Relaxed trade on "fuel efficient"- under 1000cc engine vehicles emanating from the EU. • Rebates and refunds of Customs Duties on certain green automotive products and components • Environmental levy on CO2 emissions of fuel inefficient vehicles • Rebates and refunds on biodiesel • Fuel levy not imposed on green fuels (CNG) • The RAF levy not imposed on Green Fuels (CNG) • No duty on green fuels from EU, EFTA and SADC • No Customs & Excise Duty on Cleaner Fuels • Funding of infrastructural projects under the PICC SIPs 7 and 8 • Carbon tax punishing fossil fuel users hence indirectly incentivising use of alternative fuels. • Electricity legislation providing viable but yet complicated provisions • Funding of green transport projects by the country's development funding institutions such as the IDC and the DBSA, e.g. CNG BRT buses, taxi conversions, etc. • Municipalities mandated to develop Integrated Transport Plans (ITP) and develop funding models to cater for their needs including NMT and appropriate modal split. • Subsidies offered to bus and train users	• Relaxed trade on green/alternative automotive components such as lithium ion batteries, gas containers, fuel cells, and bicycles. • No rules prohibiting conversion of vehicles to green • Green Technology Special Economic Zones (SEZs) • Manufacturing incentives under the MIDP (green and non-green)	o Exemption from non-recurring fees such as vehicle registration, income tax, import duties, Customs and Excise duties. o Preferential treatment on certain non-recurring fees such as annual licensing fees, all toll fees, value added tax. Exemption from these. o Exemption from fuel levies (in the case of low carbon fuels such as gas and biofuels). o Personal tax rebates/ refunds on the purchase of targeted vehicle technologies. o Fuel price differential between alternative and conventional fuels. i.e. keep conventional relatively expensive. o Incentives for renewable energy public and residential charging infrastructure, including sale to the grid. o Direct subsidies o Rebate on exchanging fuel inefficient cars with efficient one (such as car scrappage scheme or cash for clunkers)- resembling the taxi recapitalization programme in RSA. o Renewable energy support schemes e.g., REFIT, premium payments, etc. o Direct funding of green transport initiatives, e.g. softer or low interest loans o Extended producer responsibility requirements in and civil penalties on the manufactures who fail to comply. o Discounts o Import restrictions, i.e. high tariffs and duties. o Order for government departments to procure more green vehicles	o R&D Investments o Tax credits/ breaks for on the sale of green vehicles o Tax credits/ breaks on the sale of green fuels- e.g. no fuel levy o Direct funding/ grants to specialised workshops and dealerships converting conventional vehicles to alternative fuel vehicles o Grants/ subsidies to producers/ refiners or blenders of green fuels such as biofuels, biogas, methane gas. o Gas infrastructure rollout investment grants o Government funding institutions concessional/ low interest loans o Phase out subsidies for conventional vehicles and fuels. o Zero tax rating of raw materials to produce alternative fuels. o Investment tax allowance o Accelerated depreciation and amortization schemes

The challenge with this lack of transparency relates to uncertainties linked to not knowing what Government is considering or will do next (SA Cities Network, SANEDI and Linkd, 2014; Trade and Industrial Policies Strategies, 2018). These fuels could be the Government's next revenue streams. Linked to the discussion here is the existence of many measures which currently serve as disincentives to transport greening, hence playing a counterbalancing role, depending how they are viewed and applied. Indeed, these are the flaws which respondents in Chapter Seven lamented. They are also discussed in Chapter Five under measures that hinder technology and fuel switches. These chapters confirmed how well subsidised the country's transportation status quo is, actively supporting non-green conventional systems. Even though public transport buses and railway transportation are comparatively greener modes, most are fuelled from fossil power sources, with few examples, largely in Gauteng Metropolitan municipalities, utilising greener or alternative fuels. Worst of all, even the cleaner fuels debates introduced in Chapter Five, seems to be moving very slowly in terms of development and promotion.

When referring to green transportation in this country, resource constraints coupled with distant location to work areas, have for many years confined people's thinking to public transport (e.g. buses, minibus-taxis and trains). Many subsidies have therefore gone to funding these modes of transportation. A closer look at the 2018 budget highlights by National Treasury make the following fiscal commitments with respect to the transport sector:

> … in the next three years, R129.2 billion to support affordable public transport. There will be an increase in the general fuel levy to raise revenue of R2.6 billion. Ad valorem excise duties for luxury goods, such as motor vehicles, will be increased. The motor vehicle emissions tax will be raised to promote eco-friendly choices (National Treasury, 2018:1).

The budget focuses on conventional systems, with the environmental (vehicle tax) highly unlikely to be ring-fenced. There are also challenges with minibus-taxi industry – believed to be transporting more people than other modes, which however does not get much government support in the form of *direct subsidies* compared to its public transport bus counterparts. Instead it is being eliminated through integration to imported systems such as the BRT – a system that is currently facing many challenges and criticisms in the history of transportation systems in South Africa.

7.2.7. Incentives related challenges

Too much reliance on government-backed demand side incentives (especially the subsidies) has limitations, since their removal tends to cause market collapse. China is also reported to have experienced related challenges in the past years where subsidy cuts to BYD Automobile saw sales falling dramatically following this company's decision to increase prices as an offset measure (Reuters, 2018). China's payment of subsidies to the consumers of electric vehicles, was indeed not a cheap strategy to realise EV targets (Forbes, 2018). This could then explain China's latest rule, which saw gradual phasing out of consumer subsidies and policy shifting responsibilities for subsidies away from Government to the manufacturers as discussed in Ou et al. (2019). The subsidies are to be phased out as follows:

> Increase subsidies on vehicles with a range per charge of 180 miles (about 290km). Decrease subsidies significantly on EVs with a range from 90 to 180 miles (145-290km); and, eliminate altogether subsidies for cars with a range less than 90 miles (145km and below) (Reuters, 2018).

The mandate to shift subsidy responsibilities from Government to the manufacturers is a particular form of EV carbon credit quota (or the NEV as it is called) system. It requires manufacturers of ICE powered automobiles to add a certain percentage of vehicles into their production lines or simply purchase credits from manufacturers of electric vehicles (Hardman et al., 2018). Taking effect from 2019, and resembling California's ZEV scheme, this system intends to compel companies to either cut ICE production or move to EV production. What is interesting about this policy move is that it adopts a combination of fiscal and regulatory interventionist strategies, the so-called 'stick and carrot' approaches discussed in Chapter Three. It also resembles Brazil's RenovaBio law, which Addington (2017) believes will encourage users of flexi-fuel vehicles to use blended fuels. These new rules (in Brazil and China) are all driven by the desire to reduce greenhouse gas emissions. They both involve adjustment of the incentive mechanism, in the case of both countries – a subsidy. The subsidy is not abolished completely with immediate effect, instead the responsibility is slowly shifted to the industry using a combination of fiscal and regulatory measures (Forbes, 2018). In the case of China, while the removal of subsidies on low range electric vehicles may look like a disadvantage, the provision of another subsidy to high range electric vehicles counterbalances the effect, while encouraging continual improvement. This means, to continue benefiting from the subsidy programme, consumer demand for higher range vehicles should stimulate manufacturers to produce such vehicles. Unlike South Africa, China's policy stance is not entirely laissez-faire as it is combined with interventionist strategies.

Discussed in Chapter Three, one of the key criteria for a successful government interventionist strategy, according to Argyris (1970), is sustainability of the intervention. Once the interventionist has left, the system should not die but rather sustain itself for as long as it is still relevant and justifiable. If in the case of China and Brazil, the removal of subsidies had led to the death of the EV and biofuel industries, then this would mean: i) that these countries had failed in their attempts to encourage these transport greening technologies using subsidies;

and ii) that these countries had achieved their targets, and hence the intervention was no longer relevant or justifiable. In both cases, it was revealed that by incentivising electric vehicle and biofuel industries and consumers, these countries had indeed sacrificed revenues and in the case of China, this was estimated at $7.7 billion in 2017 alone (Reuters, 2018). In the process, however, they had developed these industries in a manner that means these countries are respected world leaders in these technologies.

The impact of alternative fuels and vehicle subsidies on governments depends on the interpreter's worldview. To some, it may seem as affecting the state negatively as they reduce the revenues that are required for spending on social programmes and/or by placing greater tax burdens on other products. To others, socio-economic and environmental benefits are uppermost. For example, in Norway, an EU country with the largest market share for new electric vehicle sales between 2013 and 2017 (EV Global Outlook, 2018), electric vehicle incentives led to the following issues:

- high public subsidies as compared to the value of the reduced carbon footprint of electric vehicles,
- traffic congestion in some of Oslo's bus lanes due to the increasing number of electric cars,
- the loss of revenue for some ferry operators due to the large number of electric cars exempted from payment, and
- a shortage of parking spaces for owners of conventional cars due to parking preferences to electric cars. The latter is exactly what the Government of Norway had intended (EV Global Outlook, 2018).

It is therefore argued in this section that, irrespective of worldviews, South Africa can learn from experiences of its BRICS counterparts and Norway, in particular. Some lessons were probably learnt from the off-road vehicle biofuel levy which, as discussed in Chapter Five, experienced many challenges. China's and Brazil's experience then become relevant if South Africa is to address fears associated with potential system collapse from subsidised transport greening. One potential counterbalance for South Africa could be increasing taxes in other revenue collecting streams. One such balancing act already contained in this country's Biofuel Regulatory Framework published in the Government Gazette (Gazette No. 43003 of February 2020) is to ring-fence about 3.5 cents to 4 cents/litre of levy currently imposed on conventional fuels and channel it towards a particular transport greening initiative (not necessarily biofuels). In the case of China and Brazil, the 'stick' approach in the form of fuel efficiency vehicle production quotas, seems to have diverted the responsibility away from Government to the industry. The starting point for South Africa could involve setting targets for the fuel economy, as these BRICS countries and others in the developed worlds have done.

Another tool available for South Africa to use is the Environmental (CO_2) levy which is imposed on the purchase of new private passenger vehicles. It is a behaviour punitive tax, which however does not seem to have succeeded in altering behaviour. The objective of this levy according to the South African Revenue Service (SARS, 2019) is to encourage the development of an energy efficient and ecologically friendly automobile fleet in South Africa. As it gets passed onto them, consumers of new vehicles pay this levy, and as such, it is a demand-targeting tool, as opposed to it being a supply targeting fiscal measure. The study, conducted by Vosper and Mercure (2016), showed that the ability of this tax to curb the emissions was insignificant in the context of growing sales of targeted vehicles, hence giving the impression that it is simply another revenue collecting stream of Government. As such, these writers criticised this policy framework for failure to achieve its intended goals.

When this tax is collected, it is never ring-fenced (channelled back to promoting greening activities). A further limitation of this tool is that it targets new vehicles, hence ignoring the life cycle impacts of a vehicle, especially during its operation stages. In South Africa, these are compounded by the fact that the fuel used is not of good quality, as it still subscribes to the old Euro 2 standards. It was shown in Chapter Five that this country remains behind the rest of the world in offering producer incentives, consumer incentives or a combination of the two. On reviewing the biofuel regimes of major producing countries, Harmer (2009) noted consistent government assistance at all stages of biofuel production and in the value chain from plantation of first generation feedstock right through to the use of final product. Hence government intervention in supporting private sector investments is not negotiable. In South Africa, there are nonetheless patches of efforts to green the sector as already shown in Table 7.4.

7.2.8. Non-motorised transport (NMT) and modal shift

In comparing the continents Europe and Africa, the FIA Foundation (2016) noted how these regions differ with respect to policies that promote non-motorised transportation. More than 60% of countries in Europe encourage this mode compared to only about 10% in Africa who do the same. Highlighting the role of strong leadership as a catalyst in promoting walking and cycling, this institution noted the role of mayors in specific developed world cities, who assisted greatly in transforming infrastructure for cycling and walking. While more than 35% of trips in such cities are completed without using automobiles, cities in Africa recorded over 80% of journeys made on foot (FIA, 2016). To stimulate NMT according to the Climate Technology Centre and Network (2019) requires a policy package consisting of various elements. These include awareness campaigns, appropriate infrastructure, enhanced public transportation and measures to discourage use of automobiles. One of the key parameters, according to this institution, therefore is high density in urban areas. An element of international organisation interventionist approach was demonstrated in 2015, when the UN Environment *Share the Road Programme* and the FIA Foundation entered into a partnership with the Nairobi City County Government to develop and launch an NMT Policy for Nairobi (Nairobi City County Government, 2015: 19). This framework sought to allocate about 20% of road construction budget to investments in non-motorised transport.

Regarding the incorporation of non-motorised transport into spatial planning in South Africa, Labuschagne and Ribbens (2014: 191) noted that this mode of transport has not yet received the attention it deserves from Government. This statement could be true given that at the time it was made, only the National Non-motorised Transport Policy of 2008 existed in this country. This policy clarified responsibilities for NMT among local, provincial and national government. When compared to Asia Pacific and Latin America, Africa, according to the report by UN Environment (2016), seems to be lagging behind in NMT commitments. A study conducted by this institution compared NMT policies in these regions, with results depicted in Figure 7.2. Of about 20 countries surveyed, each mentioned at least one record, which gave indication of that country's wish to prioritise NMT at local, provincial or national levels (UN Environment, 2016).

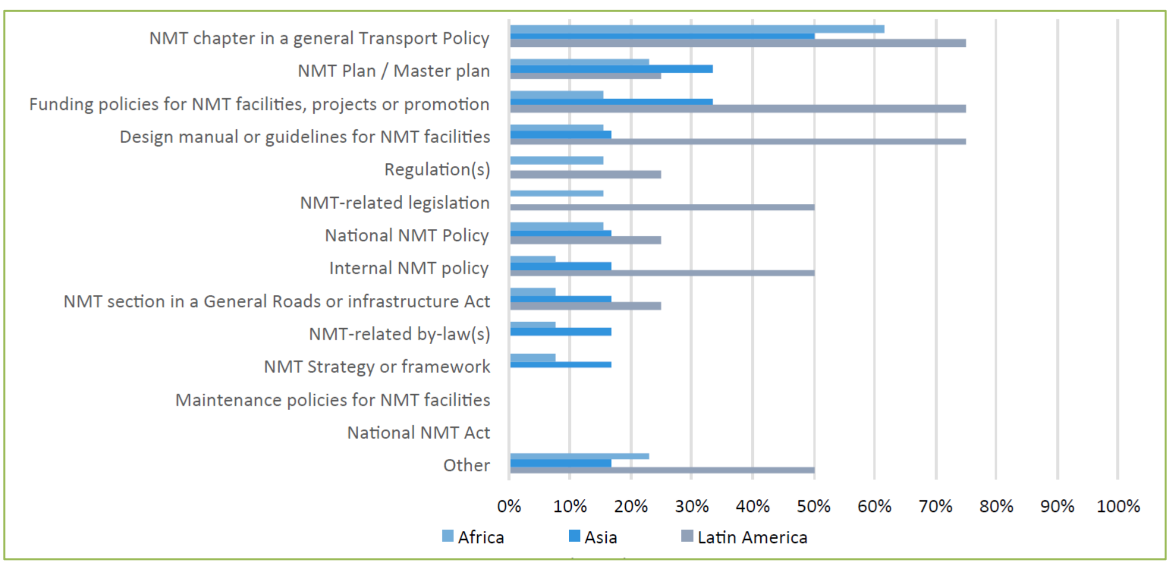

Figure 7.2: Type of NMT commitment by region (UN Environment, 2016:14)

Much was discussed in Chapter Five about the latest developments in the NMT policy landscape in South Africa with the following frameworks in particular:

- Draft White Paper on Roads Policy for South Africa (2017), which integrates NMT as a recognised mode of transport;

- 2011 National Transport Master Plan, in which NMT promotion is set as one of the short term measures (that is, 2011- 2014); and
- National Land Transport Amendment Bill of 2016 amended the 2009 National Land Transport Act (Act No. 5 of 2009). In this bill, the definition of NMT is amended, and a new section (section 10A) inserted. This section forces transport minister and relevant provincial Members of Executive Committees as well as local planning authorities to take steps to promote accessible transport and non-motorised transport.

Challenges in the South African NMT landscape still exist. One major issue relates to infrastructure, where a large focus, especially in the City of Johannesburg was on retrofitting existing roads in suburbs where people do not need this NMT infrastructure as much as in other areas (AA, 2018). Such infrastructure, according to this interview respondent, is misplaced as people in these areas either own and drive their cars or ride buses. Cycling lanes, especially 'misplaced' cycling lanes, should have been placed in areas where people actually need this infrastructure (AA, 2018).

Regarding modal shift, much was written in Chapter Five about the South African Government policy, regulatory and legislative framework around this aspect. It was also noted in Chapter Five how a number of transportation concepts and modes can be linked to the green transportation pyramid and the Avoid, Shift and Improve (A-S-I) model. The most obvious result of modal shift policies in South Africa is the Bus Rapid Transit (BRT) as well as the high speed rail transit (Gautrain) in the province of Gauteng constructed between 2007 and 2010. South Africa's BRT (Johannesburg Phase 1B in particular) has been given only bronze status (61 score) when compared with Brazil's systems which achieved silver to gold status (scoring 82-92) in the live assessment by the BRT Standard Technical Committee of the Institute for Transportation and Development Policy (2018).

Regarding the surface freight transport industry, Havenga, Simpson and de Bod (2014) cited lack of policy direction as a major hindrance to the potential role that the two modes (road and rail) ought to play. Unlike the policy framework in South Africa, Islam, Ricci and Nelldal (2016) also noted how the European Commission in 2011 published its Transport White Paper named 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system'. This White Paper sets strict modal shift targets as follows:

- 30% of road freight over 300 km should shift to other modes, such as rail or waterborne transport, by 2030, and more than 50% by 2050, facilitated by efficient green freight corridors.

- By 2050, a European high-speed rail network should be completed; the length of the existing high-speed rail network should triple by 2030 and maintain a dense railway network in all member states.
- By 2050, the majority of medium-distance passenger transport should be by rail (Islam et al., 2016).

This section compared South Africa with select countries in terms of available policy, regulatory and legislative frameworks around fuel quality, fuel economy, fuel switch and technology switch. It also provided brief comparisons in terms of modal shift and non-motorised transportation. The following section compares South Africa with other countries in terms of perspectives around the concept of transport greening.

7.3. COMPARISON OF SOUTH AFRICAN PERSPECTIVES WITH WORLD PERSPECTIVES

This section compares and contrasts South Africa's perspectives on transport greening with perspectives in other parts of the world. These are views on how transport greening is defined, how it should be undertaken, by who and what should be done, including the role and performance of Government and the private sector. Much of the discussion in Chapters One and Two provided international perspectives on the concepts of green economy and green transportation. It was also revealed that the latter is used interchangeably with phrases such as sustainable transport and eco-mobility. It is clear in these chapters that there is no universally agreed definition for what constitutes a sustainable transportation system, with Zhou (2012) and Nijkamp et al. (2001) noting this deficiency.

It was also highlighted that part of the problem emanates from quandaries existing within the environmental sciences and economics disciplines. Anthropocentric versus ecocentric views in the environmental sciences discipline as well as the existence of capitalists / neoliberalists versus the interventionists in the economics discipline and the interaction between these worldviews, play a significant role in determining the type of economy greening path countries may choose to follow. This argument is strengthened in this section, where this interrelationship between concepts is further illustrated by use of drawing as depicted in Figure 7.3. A first glance at this figure may trigger views about failure of the green economy phrase to capture the social pillar. The phrase implies a focus on the economic and environmental pillars of sustainable development, neglecting the social pillar, which is equally fundamental to all government policies. As such, the 'green economy' phrase fails to meet the criteria of concepts that can be considered to be providing a path to sustainable development as described in various models presented in Hahn (2014); Willard (2010), Leberge (2015) and Lotz-Sisitka et al. (2017) in Chapter Two. As indicated in the South African Department of Environmental Affairs (2019), Green Economy can be seen as a path to sustainable development, with transport greening viewed as simply one component of this phrase.

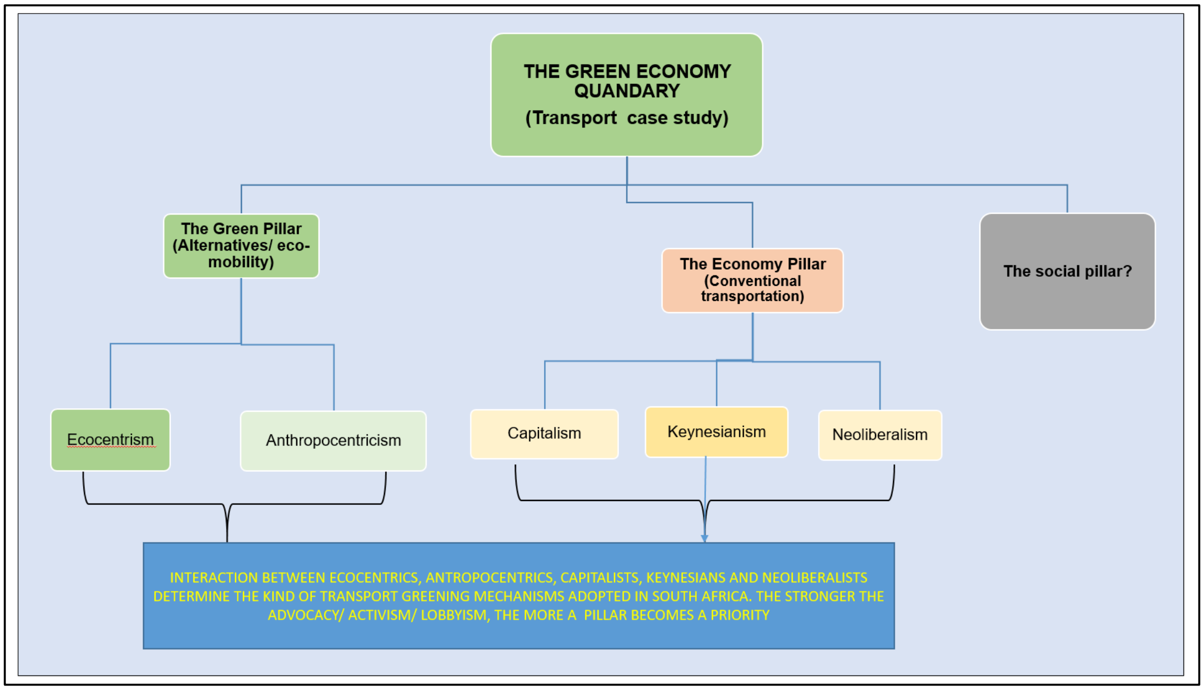

Figure 7.3: Interaction between the green and economy 'legs' (by author)

What Figure 7.3 portrays is, however, an interesting relationship between the ecological environment (the green) and the economic environmental sub-components of sustainable development. As introduced in Chapter One, these fields have their own internal dilemmas with respect to what they stand for. As a result, this section argues that these predicaments complicate matters for those that actively propagate a new world order called "green transportation" as a panacea for post-modern transport economy problems.

7.3.1. How South Africa and the world compare in defining transport greening

The way in which transport greening in South Africa is defined resembles definitions at global levels. At global level, much research on sustainable transportation has been conducted, with the main challenge, according to Zhou (2012), being lack of consensus among individual authors, entities and agencies on the definition. Various definitions of this concept were provided in Chapter Two, with most definitions, including those listed in the Victoria Transport Policy Institute (2017) TDM Encyclopaedia, incorporating the social, economic and environmental pillars. This includes definitions provided by among others, the Appropedia (2017) and Cheba and Saniuk (2016). Other writers such as Purvis, Mao and Robinson (2018), regard the absence of a theoretically solid conception of the concept of sustainability, as the main factor frustrating approaches towards a rigorous operationalisation of the concept. While most views on green transportation, according to Zuidgeest et al. (2000), are descriptive and general in nature, they usually fall within ecology-oriented definitions: the integral definitions or the process-based definitions. Ecology-based definitions, according to these authors lean towards sustainable development definitions endorsed by and promoted in the Brundtland Report by the WCED (1987). Such definitions call for a transport system that considers the needs of present and future generations. Integral definitions specify social, environmental or economical components saying that an effective transportation policy should strive towards achieving some balance in these components. It is argued in this section that transport greening in South Africa is taking place within the context of these contrasting worldviews. From the official website of the Department of Environmental Affairs (2019), the country's transport greening is seen as a key component of a green economy (a phrase that is also regarded as a sustainable development path).

The definitions assigned to transport greening by primary interview respondents, as presented in Chapter Six, were largely biased towards the environment pillar, largely climate change, if one assumes that global warming is a biophysical environmental phenomenon as defined in Twain (2020). The responses portrayed environmentally oriented worldviews, hence revealing the respondents' real or chosen inclination towards the environmental perspectives as opposed to the economic, social and industrialisation standpoints. What was interesting to note is that not all respondents were serving in environmental portfolios in their institutions, and hence could not necessarily be characterised as environmentalists. Because of the diverse and cross-cutting nature of transport greening, they were chosen and came from diverse departments including the social and economic clusters. One might thus expect a diversity of views including those leaning towards economic, industrial and social development. There could be many reasons for this pattern, including respondents' better knowledge of climate change as an environmental problem, to being completely ignorant about other environmental impacts associated with not greening the transport sector. This could also be attributed to the South African Environment Department's reputation as a 'hard core' and persistent promoter of greenhouse gas emission reduction, as may be noted in the quotation from an interview respondent from a 'non-environment' national department:

> … DEA is very strong in lobbying everyone to buy into the climate change story. It is driving the emission reduction issue. The GTS as an example, was influenced by the NCCRP. It emanates from there (BK, 2018).

Nonetheless, the environmental worldviews revealed seem to be leaning more towards anthropocentric ethics, and as such are congruent with principle 2 in Chapter 1 of South Africa's environmental legislation (NEMA, Act No.107 of 1998). This principle requires environmental management to place people's needs at the forefront of its concern, serving their interests equitably (Gazette No. 19519 of 1998). Only two definitions clearly took a balanced view, incorporating all pillars of the sustainable development framework, with only one that stood out in defence of the socio-economic pillar. Even though minor in numbers, some definitional views which took more economic perspectives were raised. These relate to the need for South Africa to generate energy from various types of sources, in a manner that ends the country's reliance on imported petroleum products. The 2018 highest price of fuel in the history of South Africa was seen as a major risk to the country's fuel security of supply, hence the call for more efforts to explore fuel greening technologies.

At the international level, models have been developed to help assist the clarification of concepts. The models introduced in Chapter Two include the green transportation pyramid and the Avoid- Shift-Improve (A-S-I) models. It is argued in this section that these models are indeed an expression of views held by those who developed them. These are views about what is / or what ought to be in terms of transport sector greening. Views on definitional issues, the status quo in transport greening, the role and responsibilities of various players including the state, all reflect the wishes of those who expressed them. There are also views on the strengths and deficiencies of current policy and regulatory regimes at global levels. For example, Aasness and Odeck (2015) praised while also criticising Norway stance on EVs. Cavalcanti et al. (2011), on the other hand, praised while also criticising Brazilian biofuel programme. Ou et al. (2019) as well as Hardman et al. (2018) highlighted how Chinese demand support tools for EVs experienced challenges, leading this country to adopt a gradual shift towards more supply targeting support measures. Gerau (2012) dubbed core countries, especially the European Union, as directional leaders, for externalising their environmental protectionist rules and values to developing nations. All these views do not automatically apply in developing countries like South Africa. The applicability of the A-S-I as a transport planning tool in South Africa's spatial planning context becomes very complicated. Complexities occur as a result of the scattered nature of residential and areas of work in South Africa from apartheid legacy spatial planning approaches. As noted in GIZ (2016), the A-S-I model states that, before improving the transport infrastructure in a city, demand for travelling should be reduced as far as possible. It assumes that one can achieve this by using an intelligent urban planning concept that lowers the distances between the facilities important for daily live. How can this be done in South Africa given the current spatial realities facing South African urban cities, where places of work are already far away from residential areas? The National Land Transport Act of 2009 discussed in Chapter Five makes provisions for municipalities to develop Transport Plans, hence allowing them to start rethinking how they can apply in practice the "avoid" concept of the A-S-I model, especially in new city developments, urban sprawl, etc.

The definitional issues covered in this section are based on a small in-depth interview sample and thus cannot be considered a full representation of how South Africans would normally define green transportation. By contrast, the public poll by Luke and Heyns (2013) involved a large sample of up to 1000 people. Unfortunately, this survey was not specifically on transport greening. There are few such opinion polls in the transport sector and little research on the perspectives around greening of the transport sector in South Africa as compared to the developed regions. This highlights a clear research gap.

7.3.2. Lack of implementation as a shared view

Perspectives on South Africa's transport sector greening were cited in Chapter Two where various deficiencies of this country's policy and legislative regime were highlighted. These reflect perspectives of individual authors on South Africa's transportation regime. One issue raised relates to the existence of enabling policy tools, with the major challenge being lack of effective implementation of these tools. A study report by the IDC and **the dti** (2017) in particular, revealed how green economy friendly South Africa is, with the main problem being lack of implementation. Using the e-mobility sector as a case, the ERC (2013) also stated its views on the country's regulatory and policy context, citing lack of a coordinated approach between the departments as a major hindrance to the implementation of needed interventions. As much as implementation deficiencies appeared on South Africa's literature reviews, these views also appeared several times during the direct in-depth interviews with participants as presented in the preceding chapter. South Africa, as pointed out by SX (2018), lacks what this respondent called a 'killer punch". This means that while the legislative framework is perceived to be in place, it is inadequate in triggering the much needed investments in transport greening. This is a view prevalent not only in South Africa, but also in other developed countries.

On reviewing transport development, Alabana, Vela, Koprencka and Petanaj (2013) noted that the challenge of developing sustainable transport policies requires orientation of the sector in a manner that contributes positively into socio-economic development and environmental protection, while also minimising related costs. While most measures required to achieve this are not new, the main difficulty, according to these authors, relates to effective implementation. A revisit of Figure 6.1 in Chapter Six reveals that many views were raised on South Africa's transport greening regime deficiencies compared to its strengths. If one were to compare South Africa with the world in terms of green transportation strengths, interview respondents in this research generally rated South Africa low. This is due to SA's comparison with developed countries. Compared with other developing countries, it is generally rated as one of the best countries in terms of policy. In their opinion poll, the IDC and **the dti** (2017) confirmed this view saying that South Africa has developed good sustainable transportation policy frameworks, with the challenge only related to implementation.

7.3.3. Shared views regarding the dominance of the global

South Africans are not alone in perceiving developed countries, especially the developed countries, as dominant players in transport greening arena. Much of this was expressed in Section 7.2, where the emission and fuel economy standards adopted in this country are very much based on the standards developed in the EU. The intentions of the Global Fuel Economy Initiative (GFEI) promoted in South Africa, were revealed in a study by Posada (2018), where all organisations involved are global in nature, working together to drive a global agenda. The EU, according to a study by Gerau (2012), has done much to externalise its environmental protectionist rules and values to developing countries. This thinking is also closely aligned to globalisation theories discussed in Robinson (2007), Wu (2016), Hurst (2018) and Major (2013), who all suggest that core countries play more influential roles in the affairs of periphery and semi-periphery countries. One interview respondent, NL (2018) labelled South Africa as a 'technology taker'. Since technologies require infrastructure, regulations, safety and return on investments, this respondent raised concerns that these factors are influenced not only at local level, but also at global levels. In other words, what South Africa ends up with in terms of type of technology, is mostly influenced by what the major green transportation developers in the world decide. They dictate the global value chains, international politics and hence the policies. In this research, views which highlight South Africa's dependency on and / or interlinkages with the international community are listed in Table 6.6 of the preceding chapter. The international community appears as the main driver of what South Africa does and what it can do in transport sector greening. Issues raised can be summarised as follows:

- ❒ Noticeable compliance with binding global commitments,
- ❒ Pressure to reduce GHGs,
- ❒ Manufacturing and export to the EU, of automotive greening components such as catalytic converters,
- ❒ Copying/ simulation of EU standards,
- ❒ Market dictatorship as a result of SA being a semi periphery country and hence a technology taker,
- ❒ Tapping into funding mechanisms such as the Global Climate Fund (GCF) and the Global Environment Fund (GEF) and know-how of developed countries,
- ❒ Importing of green transport components such as CNG and EV conversion kits,
- ❒ South African dependency syndrome – relying on the developed worlds to purchase SA-made green automotive products.

The Chief Executive Officer of South Africa's automobile manufacturers association (Mike Mabasa) was quoted on Engineering News (2020) as saying that South Africa's automotive industry is currently working with Government to develop a position paper on electric vehicles. This work entailed engagement on various themes, with the final paper earmarked for use as an advocacy tool to lobby not only the South African Government, but also their parent companies for a share of future EV production (Engineering News, 2020). This is another statement which seems to suggest the power of global influence, when OEMs present in this country can only make future decisions based on the decisions at their headquarters. These headquarters, as indicated in the report by OECD (2016), decide on the vertical or horizontal structures of their businesses, and what lines of production to give to countries that mostly assemble the automobiles.

7.3.4. Lack of coordination as a shared view

Existence of know-how as well as policy frameworks was cited as a strength in South Africa. However, this and other strengths discussed in Chapter Six, are offset by many flaws. One of the most frequently raised flaws relates to the lack of coordination/ cohesion. Lack of coordination and fragmented approaches to transport greening also feature prominently in this country's literature on transport sector greening. This is linked mainly to the cross-cutting nature of transport greening and many mandates pursued by various government departments. This includes perspectives provided in Suleman, Gaylard, Tshaka and Snyman (2015); Vosper and Mercure (2016), ERC (2013), Mitchel and Walters (2011) and a study by **the dti** (2016). Common issues highlighted in these studies include lack of coordination and integration among various programmes of Government. What is interesting to note though is that this issue is not merely a developing country issue as similar challenges were (at some stage) experienced in the now developed countries such as the USA. Hall (2006) noticed that in the USA, the major obstacle to sustainable transportation was lack of an integrated approach to decision making within the federal system. This author summarised factors which had a negative influence on the US ability to implement national policies on greener transportation. The situation seems to have improved in the USA as noted in Lu (2018); Zhang, Xie, Rao and Liang (2014) and Baran, Fernando and Legey (2013). These writers discuss various policy interventions not in place to promote the adoption of transport greening technologies, which include electric vehicles and biofuels.

7.3.5. Lobbying, over-subsidisation and role of the private sector

Lobbying is used interchangeably here with the concept of 'rent seeking'. It was raised by respondents in Chapter Six as one of the most serious flaws in South Africa's transport greening system. Defined in the Investopedia by Majaski (2019), rent seeking is an economic concept that occurs when an entity seeks to gain added wealth without any reciprocal contribution of productivity. It is regarded as the easiest and less risky way of making income. Economists, according to Henderson (2019), utilise this concept to describe preferential treatment that people or companies seek from government agencies. A better term, according to this writer is ‘privilege seeking’ and the following example if given: when company A requests a subsidy or a tariff for a good that it produces or by getting a special regulation that limits competition. Much was discussed in Chapter Five about SA’s conventional automotive and fossil fuel industries in terms of over-subsidisation. The issue of over-subsidisation also featured prominently in the respondents’ views discussed in Chapter Six. The private sector is perceived to have an important role to play, as was also raised in the public opinion poll by Luke and Heyns (2013). It should nonetheless be noted that in South Africa, there is much lobbying for specific transport greening technologies, with the electric vehicle industry, the fuel cell industry, the compressed natural gas industry strongly lobbying for Government recognition and prioritisation of their technologies.

Whether by conventional or by greener transportation industries, lobbying is a particular form of marketing. What matters is how it is done, with bad practice being lack of integrity and transparency in the pursuit of individual interests at the expense of others’ interests. This is a form of disproportionate lobbying which Jenkins and Mulcahy (2018) argued, has potential to result in administrative bribery, political corruption and undue influence over public policy making. This may result in decisions that do not always uphold public interest, with the ensuing relationships between lobbyists and policy makers likely to result in policy capture or even state capture (Jenkins and Mulcahy, 2018). Citing the routine castigation of lobbyists by politicians across the political spectrum, Hasen (2012) noted how the former US president Barack Obama developed the ‘first of its kind’ regulations to manage lobbying behaviour. It is therefore argued in this section that perceptions around the issue of lobbying, are not specifically South African. It is further argued that this issue is gaining more recognition, especially in the context of current ‘state capture enquiry’ into the South African Government’s interaction with private sector institutions. Lobbying becomes detrimental if done by the conventional industry as a barrier to limit entrance of green technologies. Based on this, one can therefore note a broad spectrum of opinions about the role of lobbying in democratic societies. On one hand, lobbying can be viewed as a misrepresentation of democratic values, while on the other, it is regarded as an indisputable democratic right displaying citizens’ freedom of expression on matters related to government decision making. It can be regarded as a tool of engagement as it can enable interest groups to understand, track and shape the development of legislation and regulation, and as such it can be a key element of public decision-making processes (Jenkins and Mulcahy, 2018).

7.3.6. Technology neutrality as a shared view

Regarding views on the preferred choice of green transportation technology/mode in South Africa, this category appeared as a third largest category in the research data as was portrayed in Figure 6.1 in Chapter Six. From most frequent to least, technology neutrality, electric vehicles and modal shift appeared as the most referred to green modes of transportation. As a dominant sub-category, views on technology neutrality called for South Africans to not choose, but rather embrace all green transport technologies brought to this country or invented in South Africa. The key message here is that the neutral route is only perceived as a short-term move and selecting particular technology as a long term strategy. How does this thinking differ from the way Europe, US, Latin America and Asia-Pacific has pursued transport greening? It was shown in Chapters One and Two that these countries adopted various technologies, hence implying some technology neutrality in their approaches. A good example in the European Union is revealed in the Clean Power for Transport package, which aims to facilitate the development of a single market for alternative fuels for transport in this region towards compliance with the requirements of the Directive 2014/94/EU (European Commission, 2019). This directive requires member countries to adopt greening fuels which include electricity for use in vehicles, compressed natural gas (CNG), Liquefied Natural Gas (LNG), hydrogen and biofuels. The directive states the following points, which highlight technology neutrality in this region:

> Without prejudice to the definition of alternative fuels in this Directive, it should be noted that additional types of clean fuels exist that can represent potential alternatives to fossil fuels. Promising results from research and development should be considered when new types of alternative fuels are selected. Standards and legislation should be drawn up, without giving preference to any particular type of technology, so as not to hamper further development towards alternative fuels and energy carriers (EU Directive 2014/94/EU: L307/2).

While the decisions on the weighting of technology choices is left to the discretion of individual countries, the basic principle inherent in the European Commission's approach avoids bias towards a particular greening technology. This partly explains a variety of transport greening technologies adopted in each country, as depicted in Table 7.5. Certain countries have chosen more specific technologies than others. In the EU, a region which inspires South Africa, there are no signs of 'technology picking', with the following table illustrating this point. The EU identified these fuels as the principal alternative fuels with a potential for long-term oil substitution. What is remarkable is the way electricity features in all EU countries' transport greening technology mix. In the current research, electric vehicles appeared as the second most preferred technology after technology neutrality. It is not clear why, but with the European Union having been viewed as a global directional leader, as revealed in the Jordan case by Gerau (2012), it is highly likely that EU ideologies have also spread to South Africans as discussed in sub-section 7.3.5. In this research, the South African Government's decision of not picking one particular technology was welcomed by the research interview respondents.

Table 7.5: Transport greening technologies in the select EU countries (by author from the European Commission, 2019)

Country	Current technology
Sweden	Electricity, Biofuels, CNG, Hydrogen, LNG
Slovenia	Electricity, CNG, LNG, Hydrogen, LPG
UK	Electricity, CNG, LNG, LPG, Hydrogen
Austria	Electricity, CNG, LPG, Hydrogen
Belgium	Electricity, CNG, LNG, Hydrogen, LPG.
Germany	Electricity, CNG, Hydrogen, LNG, Other
Greece	Electricity, CNG, LPG
Spain	Electricity, CNG, LNG, Hydrogen, LPG
Finland	Electricity, CNG, LNG, Ethanol, Hydrogen
France	Electricity, CNG, LNG, Hydrogen, Other

The call for a technology neutral route is based on ideas that this should give the country some time to adjust while learning about all transport greening technologies and choosing the best options for the country, embracing a basket of technologies rather than hastily selecting one. While arguments for the neutral route were made clearly and unapologetically, none of the respondents quantified the long term versus the short term effects of 'technology picking' against technology neutrality.

While the Government of South Africa seems to have taken a generally neutral role in choosing greening technologies, it is not uncommon however to witness specific transport greening modes taking centre stage. The obvious example is conflicting views regarding the country's Bus Rapid Transit (BRT) system and from officials at national, provincial and municipal levels. This Brazil-based model seems to have received unprecedented support at political, planning and decision making levels. Recently, it has faced various challenges.

7.4. RECOMMENDATIONS AND A MODEL TO INFORM POLICY DIRECTION

Banister (2008) noted that addressing transport related problems requires a more holistic perspective, integrating decision-making across sectors. There is thus no blueprint for a perfect model, with each situation requiring its own assessment and application. Such systems should allow flexibility, enabling easy adjustment in times where the initially set objectives do not tie up with the results. It is therefore argued in this section that South Africa shares similarities with what Banister alludes to, with transport greening matters cutting across the mandates of many departments. There are hence many options for this country and these have been raised in various platforms including the research documents by public and private institutions and in conferences, workshops and other platforms organised by private and government sector institutions. Proposed interventions differ from one institution to another and in most cases, these reflect the aspirations of those behind such events and platforms.

From a policy point of view, options available to South Africa range from doing nothing (business as usual), setting targets and picking a specific technology right through to the adoption of all potential transport greening technologies available in the country. Any choice according to Banister (2008), however, depends on a series of factors including the risks associated with it as well as the speed at which one is able to respond in correcting any unintended consequences emerging from the process. This presents a real policy challenge, which the author attempts to address in this section through the identification and highlighting of options and development of a model to inform policy direction. The status quo in South Africa points to the existence of baseline information, programmes and projects aimed at greening the transport sector. The policy recommendations in this section build from this baseline. They aim to address barriers and concerns that were identified in Chapters Five and Six and to enhance the strengths that were identified in the same chapters. While strengths provide good signals, Forbes Coaches Council (2017) warns that they can easily turn into weaknesses if they are not well managed.

Most strengths and weaknesses found in this research relate to fuel quality, fuel economy, fuel and technology switch, modal shift as well as non-motorised transport. Compared to other modes, modal shift from road to rail, use of public transport and non-motorised transport seems to be attracting more attention at policy and political levels. The Bus Rapid Transit (BRT) system and the infrastructural projects are prioritised through initiatives such as SIP 6 and 7 discussed in Chapter Five. Hence, the policy options and recommendations made in this chapter are biased towards the cleaner fuels, fuel economy as well as the switch to alternative fuels and vehicles, since this is where major limitations and hence opportunities exist.

7.4.1. Minimise the “disguising of socio-economic wishes into environmental wishes”

One flaw identified during the research relates to the lack of coordination within various departments and spheres of Government. This appeared in the South African literature documents reviewed as well as in the in-depth interview data presented in Chapter Six. This raises many issues which can best be explained and perhaps resolved using the systems and the interventionist ideas introduced in Chapter Three. The current approaches to greening this country’s transport sector remain fragmented, with many players with varying and often conflicting interests. This is true within and across Government, within and across the transport industry and between Government and industry. When greening measures are initiated, this is often to respond to these interests. This is not necessarily wrong, but does seem to be the reality when it comes to transport greening in this country.

Sometimes greening initiatives occur unintentionally, often as a by-product of a different goal/ initiative. One example relates to the levy imposed on new vehicles. Vehicles are taxed with an environmental (CO_2) levy with the objective of changing behaviour by influencing the composition of South Africa's (SA) vehicle fleet to become more energy efficient and environmentally friendly (SARS, 2020). Backed by research conducted by Vosper and Mercure (2016) as well as the commentary by Curran (2019) in the Grantham Research Institute on Climate Change and the Environment, it is argued here that the stated objective of the CO_2 levy on vehicles is simply a 'disguised' rationale. The same applies to the CO_2 fuel levy, unless this will eventually form part of funds that will be channelled towards the biofuel programme. At present the monies collected go into the country's national pool of funds. Manufacturers simply pass the costs on to the consumers, and as such, raise suspicions about real rationale. There does not seem to be logic in discouraging the use of inefficient vehicles when there are no cheaper alternatives on the market. Various factors prohibiting the availability of these alternatives were discussed in Chapter Five, including poor quality fuels produced in the country and high costs of efficient vehicles currently imported e.g. EVs.

Many related examples, including the Plastic Bag levy, can be used to support this argument. As noted in Erdmann (2018), only about 15% of this levy was channelled to the government-controlled plastic bag waste management NGO (Buyisa e-Bag). The rest remained in the Government's national pool of funds. If the idea was to change behaviour, there are no examples of alternative bags made available to the market, besides Buyisa e-Bag, whose existence was short-lived. Within Government alone, certain goals get camouflaged as transport greening. The hype about fuel cells as well as catalytic converters is not about greening (in South Africa) but rather about selling Platinum Group of Metals (PGMs) as revealed by TK (2018), a self-confessed promoter of hydrogen fuel cell industry in South Africa. It is also tempting to argue that the primary goal of lobbyism by various interest groups, including those promoting electric vehicles and compressed natural gas, is not about greening per se, but about selling these vehicles and associated energy and infrastructure. As noted by BK (2018), in Table 6.4, the country's utility company, Eskom, is looking forward to electric vehicles in this country, as this will provide additional markets for its electricity, which is mostly generated from fossil fuel coal. The list goes on. While this country was flagged by the Union of Concerned Scientists (2020) as one of the biggest emitters of GHGs, to address this, South

Africa's ratification of international agreements has been conditional on the developed countries providing various forms of support as noted in the Department of Environmental Affairs (2018).

Most examples provided in this sub-section attempt to highlight what is termed in this thesis as 'socio-economic wishes disguised as environmental wishes'. It is further argued that such behaviour is misleading, not least in terms of South Africa's real efforts in addressing its large environmental footprint.

7.4.2. From the little we have, "create"

The first task of the centralised institution proposed in the preceding section could be to assist the country to build from the status quo, capitalising on the positive policy frameworks already established. Globally, economic and financial incentives have been used successfully to stimulate much needed changes in transport sector greening. The tables below build on South Africa's specific policy proposals to address the challenges.

Table 7.6: Addressing barriers to fuel and technology switch (by author based on the findings from Chapters Five and Six)

Policy barrier to technology switch	**Possible policy mitigation**
High import duties on complete green cars	Reduce EV tariffs to a level sufficient to stimulate demand, e.g. 0% for a period of 3-5 years, or else reduce from 25% to 18% to provide a globally harmonised system with conventional automobiles.
Ad valorem excise duty on green cars	EVs imported to SA are not luxury cars and as such the revision of and removal of 18% tax is needed in order to reduce price and stimulate demand.
Rigid application/ or misinterpretation of finance and procurement rules	Green cars are not cheap, at least in the short term, and as such, the cheapest quote principle of the PFMA and regulations can be waived, especially where local procurement is involved.
"Heavy" subsidisation of conventional automobiles	Incorporate in the 2035 Master Plan or automotive incentives, green requirements, e.g. funding of locally produced vehicles meeting a certain fuel economy target.
Requirements for vehicle homologation	This is a critical requirement, and should not be seen as a barrier. Instead, the affected local innovators of green automobiles should be supported through direct funding to cater for higher costs.
Policy barrier to fuel switch	**Possible policy mitigation**
Over-subsidisation of conventional fossil fuel industry OP26 - Tenth Schedule	R&D, exploration and production tax deductions (150%, 200% and 150% respectively) offered to oil and gas companies, review and where possible provide related incentives to alternative fuel companies.
Promulgated but not yet implemented legislative framework to incentivise biofuels	Develop the incentive mechanism, and start selecting and funding feedstock suppliers and manufacturers of biofuels.
Fuel levy imposed on biodiesel	Implement biofuel support scheme, incentivising feedstock and fuel producers.
Value Added Tax (VAT) imposed on green fuels (CNG, CBG and	Government needs VAT, and hence these taxes should remain as long these fuels are officially exempted from the

electricity)	fuel levy. Currently Government is silent.
Import duty imposed on green fuels from Mercosur and General member states	To develop the local biofuel industry, keep the tariffs high.
Gas not yet declared as an energy source for vehicles	A clear policy statement declaring gas as a fuel for transport, needs to be made either in the Gas Act or through a separate government process. The statement should also indicate that the fuel levy will not be imposed on this fuel for a given period.

Transport greening programmes in various parts of the world have adopted numerous approaches, including the use of both supply and demand targeting tools. The demand tools have yielded positive results, especially for a given period of time, after which problems start to creep in. China, Norway, Brazil and the state of California were used as case studies to highlight this argument, hence encouraging these countries to move to the next level, including tapping into supply-targeting tools. The good examples are Chinese New Energy Vehicle (NEV) quota scheme and California's Zero Energy Vehicle (ZEV) credit scheme as discussed in Ou et al. (2019) and Hardman et al. (2018). Brazil's RenovaBio scheme, noted in Addington (2017), is another example. Indeed, the South African Government, as noted in Chapter Five, has not been doing nothing. Instead, it has designed various policy, regulatory and legislative frameworks to support the transition to eco-mobility. What is lacking, however, as argued by SX (2018) in Chapter Six, is a "killer punch".

There are examples of several projects and policy interventions initiated in South Africa, which have been, either left incomplete or abandoned. Examples highlighted in Chapter Five and summarised in the preceding sections, include the incomplete Euro 5 equivalent Cleaner Fuels 2, the Fuel Economy Standard which has no real fuel economy targets. These initiatives are, however, an indication of the country's interest in transport greening. In the European Union, most transport greening initiatives (with the exception of a few countries) seem to have been driven by fuel economy standards, with industry players competing for the production of and making available to the market, improved and fuel efficient vehicle models. Unlike Table 7.6 above which provides options for addressing existing gaps, the table that follows seeks to take advantage of existing strengths and add further benefits to the country's green transportation agenda. These strengths were identified in Chapter Five and Six, and also summarised in the previous sections of this chapter. Here, actions to enhance these strengths include the proposed centralised *institution/ structure*, which can commence with the prioritisation of areas recommended in Table 7.6 above and Table 7.7 below. Linked to the *build from what we have* policy recommendation, is the issue of existing internal combustion engines, which require a gradual transition to the next phase.

Table 7.7: Enhancing existing strengths, encouraging fuel and technology switch (by author based on the findings from Chapters Five and Six)

Strengths to technology switch	Recommended policy action
❒ Relaxed trade on green automotive components	Maintain this to encourage importation of components for local assembly in South Africa.
❒ Abolishment of import duties under the TDCA	Maintain this for the under 1000cc vehicles, because they are fuel efficient – doing so should encourage competition, hence forcing local auto manufacturers to make and assemble these small machines locally. Furthermore, insert a clause in the auto incentive scheme, obliging local manufacturers to add these vehicles into their production lines.
❒ Rebates and refunds of Customs Duties on automotive products and components	Maintain this to encourage importation of components for local assembly in South Africa.
❒ Environmental levy on CO_2 emissions of fuel inefficient vehicles	Maintain this but also ring-fence at least a portion of the levy (5-10%) to fund green transport initiatives such as taxi or bus conversion to use low carbon fuels, or fund EV public charging and CNG refuelling stations.
❒ No rules prohibiting conversion of vehicles to green	Like with the CNG proposal above, make a clear policy statement or a guideline to minimise interruption in the business of SMME doing the conversions. Unlike the complicated standards and specifications, the guideline should be aimed at minimising the safety risks associated with the conversions.
❒ Green Technology Special Economic Zones (SEZs)	Encourage green transport related component producers to locate within these zones.
Measures promoting fuel switch	**Recommended policy action**
❒ Rebates and refunds on biodiesel	Maintain and where possible enhance to include other customers in addition to those currently targeted.
❒ No fuel levy imposed on green fuels	Maintain this, but accompany with a clear policy statement, stipulating the date by which the levy will be imposed.
❒ RAF levy - not imposed on Green Fuels	Same as above - maintain this, but accompany with a clear policy statement, stipulating the date by which the levy will be imposed.
❒ No duty on green fuels from EU, EFTA and SADC	Maintain this as SA still needs cheap CNG from Mozambique.
❒ No Customs & Excise Duty on Cleaner Fuels	Maintain this, but accompany with a clear policy statement, stipulating the date by which the levy will be imposed.
❒ Carbon tax indirectly incentivising use of alternative fuels	Use carbon tax on fossil fuels, but like the CO_2 levy, ring-fence a portion of it to fund transport greening projects.
❒ Electricity legislation providing viable but yet complicated provisions	Fund and set tariffs for renewable energy public charging stations, while also relaxing licensing requirements.

South Africa has indeed added new greener vehicles into its fleet, though the numbers are still small as indicated in Chapter One. Pojani and Stead (2015) noted that this country should diversify its transport greening measures without being biased towards a particular kind of policy measure. A wide range of vehicles in the form of passenger cars, heavy-duty trucks, garbage trucks and buses in South Africa, can be powered from several types of greener fuels produced from renewable sources. These vehicles can also use biodiesel without necessarily requiring any modification of the said vehicles. The exception is use of bioethanol and other energy sources such as electricity and compressed natural gas, as these do require such vehicles to undergo some form of modification.

7.4.3. Implement a "polluter pays" and a "preserver praise" principle - the 4P model

Based on the literature findings as well as results of this research, this sub-section proposes a *4P (polluter pays and preserver praise) model*. One way of praising 'eco-defenders' (or 'environment preservers') is to 'take from the bad guys and give to the good guys' – a redistribution technique through a ring-fencing mechanism. Currently, the CO_2 tax has a behaviour-changing objective to discourage buying of fuel inefficient vehicles, but provides no incentives to the buyers of fuel-efficient vehicles. The literature supports the ring-fencing technique. See, for example, Banister (2008) who had much to say about key factors to consider when transitioning to a cleaner mobility regime. Any measures, which according to this writer discourage use of automobiles, should be pursued in conjunction with initiatives promoting use of cleaner alternatives. Supported from funds collected from measures adopted to punish single car users, these alternatives should be made known to the public.

Contrary to this, South Africa's finance authorities do not seem to support such a policy stance. Research on the efficiency of "behaviour targeting" objectives of such levies as the CO_2 levy, has proved that the levy leads to no changes in behaviour as consumers continue buying fuel-inefficient vehicles as noted in the Vosper and Mercure (2016) study. The impact of the recently added carbon tax (i.e. the CO_2 fuel levy) is yet to be realised. But observers have already slammed it as yet another revenue collecting tool, as noted in Curran (2019). The recommendation in this thesis is that Government should redistribute the whole or part of behaviour punishing fiscal instruments such as the CO_2 levy towards efforts aimed at supporting alternative fuels and vehicles. The same can be done with a portion of the fuel levy to fund, for example, biofuels or other green fuels. At least a positive signal is now created by Government's recent promulgation of the Biofuel Regulatory Framework, as it provides for incentives to fund suppliers of feedstock and producers of first generation biofuels (Gazette No. 43003 of February 2020). What is left now is implementation, which is facilitated through a multi-departmental Biofuels Task Team (BTT) chaired by the Department of Energy or the Central Energy Fund. To be funded from a fuel levy, the Biofuel Regulatory Framework is proof that ring-fencing is possible in Government. It has been done before, with the Plastic Bag Levy, where Buyisa e-Bag, a former entity of the National Department of Environmental Affairs, was established. Further examples include the "Redisa debacle", a model that attempted to apply an Extended Producer Responsibility (EPR) concept promoted through the country's Waste Management Legislation (Act No. 59 of 2008) promulgated in the Government gazette (Gazette No. 32000 of 2008). Also the Road Accident Fund Levy provides further proof that ring-fencing, as a policy tool, is possible in South Africa. The failure of some of these ring-fenced beneficiary pilot projects should not be used as a benchmark for other related projects. It is argued in this thesis that the challenges experienced by these projects had nothing to do with the inefficiencies associated with ring-fencing approach, but rather the institutional, governance and management arrangements adopted during the implementation stages as argued in reports by Bizcommunity (2020) and Erdmann, 2016). The main problem according to Bizcommunity relates to the choice between Section 28 (government led plan) against section 18 (industry-led extended producer responsibility), with the latter being the preferred route.

It is acknowledged that this proposal may not necessarily be in line with policy wishes and goals of the country's Finance Ministry. Nonetheless, it is presented here as an option whose benefits have not been explored in SA's transport greening agenda. It has been tried successfully elsewhere in the world in the form of green bonds issued by either Government, large corporations or banks (OECD, 2015). Green Bonds, according to UITP (2019), have been used in London, Paris and Gothenburg to invest in developing public transport. The ring-fencing topic was also raised in Chapter Six, though with mixed feelings – some respondents preferred it, while others such as MM (2018) did not. Currently, there are many taxes imposed on citizens and any additional taxation, was hence viewed as unfair and unnecessary.

7.4.4. Set supply-side fuel economy targets while encouraging local manufacturing

This mechanism, used in the European Union, follows a technology neutral route. Countries in the EU compete by making available the most fuel efficient vehicles in the market, driven by strict targets. This was rated high on the list of green transportation choices by participants in this research. In other words, due to the many green transportation technologies pursued in South Africa, technological neutrality was deemed the best policy position for the country. Fuel economy targets have the potential to help South Africa migrate speedily to improved automotive technologies. By 2050 and beyond, improvements in carbon dioxide emissions will probably depend on advances in automotive efficiency technologies, alternative fuels and changes in behavioural changes. South Africa can gain significantly therefore from this. Conforming with the fuel economy best practices is also critically important for South Africa in the context of automobile trading with European countries, where stringent compulsory emission control and fuel economy targets have been set. South Africa exports comparatively large volumes of vehicles to these countries. With 2030, 2040 and 2050 ICE ban targets in these countries, South Africa has to start producing automobiles that will meet the export country requirements, with the setting of real fuel economy targets (as undertaken in the EU) holding potential for South Africa. This is needed to stimulate the local market for fuel-efficient vehicles, while at the same time boosting manufacturing capability and supply of these vehicles.

On the manufacturing side, the Joule project is one of South Africa's abandoned and forgotten innovations that had potential to place this country on the electric vehicle world map. As noted by NL (2018) and TS (2018), South Africa brought the Joule in too early, with the threshold of 50 000 units to quality in the Government automotive support scheme, also having contributed in weakening its position. ERC (2013), cited exactly this competition with major OEMs as having contributed to the problem, but also the global market for EVs was very limited. As noted in Chapter Five, the Chinese EV industry did not grow out of traditional OEMs alone. Instead, the Government incentivised expansion allowed nascent and privately owned automakers to compete with established automakers (Ou et al. (2019). Elon Musk's Tesla provides another example of a successful EV manufacture by a non-traditional automotive OEM.

These arguments therefore seek to highlight a view that the time is now right for South Africa to take off from where it landed, or start on a clean slate by developing its own energy efficient automobiles, as with the Joule project. In other words the Joule should not be viewed as a failed and hence a dead project, but rather as a starter, which served to warm this country up in preparation for what is now regarded as one of the key options for the world's future mobility (Electric Vehicles). Various tools available to Government, according to Banister (2008), include legislative and financial incentive frameworks, where these should all be used to encourage manufacture of green transportation technologies.

7.4.5. Make clear policy statements

South Africa needs to provide policy statements/ assurance confirming cleaner fuels such as CNG and renewable electricity as transport fuels, highlighting incentives associated with switching to them. Unlike hydrogen fuel whose use is still at the research stage given the nascent nature of the fuel cell industry in the country, electricity and compressed natural gas fuels are already being used in South Africa. Many vehicles as reported in CNG Holdings (2015), Matlhale (2015), Creamer (2017) and Sandton Chronicle (2014) have been converted to use CNG and electricity (see Chapter One). The national Government (specifically the Department of Energy and National Treasury) in South Africa, exercise control over energy supply, using legislative provisions that impose rules on, among others, taxation and rebates. This hence presents Government with an option to utilise energy legislation to offer preferential rates on cleaner fuels benefits that are likely to pass on to consumers. As such, Government needs to make clear policy statements regarding its position on various green fuels that are currently unregulated for use in transport. Currently, Government is silent, since the Gas Act (Act No 48 of 2001) does not explicitly include the gas as a recognised transport fuel. No fuel nor road accident fund levies are imposed on gas, which makes it 'fictitiously' cheaper and hence attractive to the users, compared to other legislated fuels such as petrol and diesel.

While this is good for the users, silence on the part of regulatory authorities creates uncertainties.

7.4.6. Lead by example by setting tangible green procurement targets

Government does business with many companies and they are not obliged to add any green fleet. Examples include Avis, Budget, shuttle service providers, as well as public bus operators, who get massive subsidies from Government. Using provisions in Government procurement legislation, specific clauses in the contracts signed between transport service providers and the state, can be used to require addition of green automobiles to the fleet rented to the state. In addition, Government purchases significant volumes of fleet for various services including police, military and other general-purpose use by various departments. It hence possesses huge purchasing power, where reasonable commitments to the purchase of greener automobiles, present opportunities for enhanced public awareness. The old and abandoned Government vehicles (trucks and buses), especially those from the military, can be resuscitated and converted to run on compressed gas or electricity as suggested by SX (2018) and in the process, gas and electric charging stations can be expanded. At the time of submitting this thesis, the author was aware of ongoing processes within the Department of Transport, to develop guidelines for Government green procurement of transport goods and services. This is an initiative conducted as part of implementing the Green Transport Strategy (DoT, 2018).

7.5. LOCATING RECOMMENDATIONS IN THE GREEN TRANSPORT POLICY MODEL

Transport greening requires the application of transport planning principles, which in the case of South Africa requires coordination within and between various departments and spheres of governance. The recommendations above may assist in providing the policy “killer punch” referred to in Chapter Six. While it is hard to set actual implementation time frames given the existence of many competing factors, Figure 7.4 presents a roadmap with proposals on how recommendations could be implemented. It is argued that the implementation could be done through existing structures in Government or through the setting up of a coordinating structure comprising representatives from various spheres of Government. The role of a high level green economy coordinating institution/ structure will be to facilitate green economy related policy initiatives, including those related to transport sector greening. This institution can be a central point, providing oversight and strategic direction to Government on all transport greening matters. It is an entity that can pull together (using multivariate and/or multi-criteria techniques) Government departments with often competing mandates, to make collective decisions on the best options for the country. The rationale behind the proposal to set up such institution is based on the multidisciplinary nature of transport greening, the cross-cutting nature of transport greening mandates and associated system deficiencies. The lack of coordinated efforts in transport greening is an issue that emerged prominently in this research, from literature documents and from primary data collected through interviews. In developing the model depicted in Figure 7.4, the following assumptions were made based on the literature reviewed as well as the research findings presented in Chapters Five, Six and Seven:

- South Africa's policy frameworks will continue to be influenced by developments and decisions at international level, with core countries playing a pivotal role, as has always been the case.
- South Africa already has a wealth of transport greening policy options, including those targeting fuel quality improvements, fuel economy, fuel switch, technology switch and modal shift including NMT, however the country still requires incentive mechanisms specifically targeting greening of these options.
- The immediate policy approach will be to embrace and implement all transport greening measures and technologies available to the country at present, hence more at stages 1 and 2. This involves picking and prioritisation of "low hanging fruits". Some low hanging fruits have been identified in this thesis – see Tables 7.6 and 7.7 and recommendations in sub-section 7.4.
- As South Africa becomes more accustomed to various technologies and increases understandings of the performance of each technology and policy option, it can begin to streamline its efforts towards more focused and efficient options, demonstrated by the shrinking size of the model stages 3 and 4. More energy efficient, an improved range and affordable automobile technologies such as battery electric vehicles (BEVs); Plugged-in Hybrid Electric Vehicles (PHEVs) as well as Hydrogen Fuel Cell Vehicles (HFCVs) are likely to form part of these stages. Better policies and incentive mechanisms will also have been developed and implemented.
- Transition from one stage of the model to the next will require a monitoring exercise, to determine performance in the achievement of targets set. The model comprises four stages summarised as follows:

7.5.1. Stage 1: Status quo review

It is argued here that this stage can be considered to be covered partly by this thesis, as well as in other policy and research documents alluded to in this thesis and in other research documents. This involves identification of existing policy, regulatory and legislative frameworks, analysing the strengths and weaknesses. This stage forms part of what has already been done in this research, with Government only required to continue from where this research and other related research studies have ended. Next Government needs to develop consensus, setting clear transport greening policy goals moving forward. This is partly gone in the Green Transport

Strategy, where bias in this strategy towards climate change, is deemed to be limiting in implementing the initiatives using this model.

7.5.2. Stage 2: Implementing low hanging fruits (2020-2024)

This assumes that the initiatives envisaged under this stage could be implemented within a period of four years. These activities are placed in stage 2 since they are already happening in government processes.

- Finalise GTS green procurement rules – this is only one of the initiatives under the green transport strategy, but is considered key to triggering Government thinking on the procurement of green transport goods and services.
- Public transport infrastructure roll-out and enhanced awareness campaigns to promote modal shift from private vehicles to public transport
- Road to rail and roll-out of non-motorised transportation (NMT) technologies and related infrastructure.
- Implementation of transport NAMAs as provided for in the Transport Flagship Programme of this country's National Climate Change Reduction White Paper.
- Roll out more Research and Development (R&D) pilot projects and commercialisation of some that have already been piloted. Examples include the work of HYSA, uYilo mobility programme.
- Awareness raising, continued public procurement of green buses at municipal level, targeted support to the minibus-taxi industry, decisions on appropriate support incentives for local manufacturing, conversion of old vehicles and supply of green automobiles, break the silence and make clear policy positions on the use of green fuels like CNG, CBG, hydrogen and electricity.

7.5.3. Stage 3: Finalise outstanding policy frameworks (2024-2028)

There are a number of policy frameworks that have been left incomplete. It is therefore argued here that Government needs to finalise CF2 and decisions on refinery upgrades to accommodate more fuel efficient vehicles, set mandatory vehicle fuel economy targets, more public procurement of green automobiles and setting up of related infrastructure, implement incentives to support local manufacturing of green automobiles (i.e. ring-fenced incentives including green bonds).

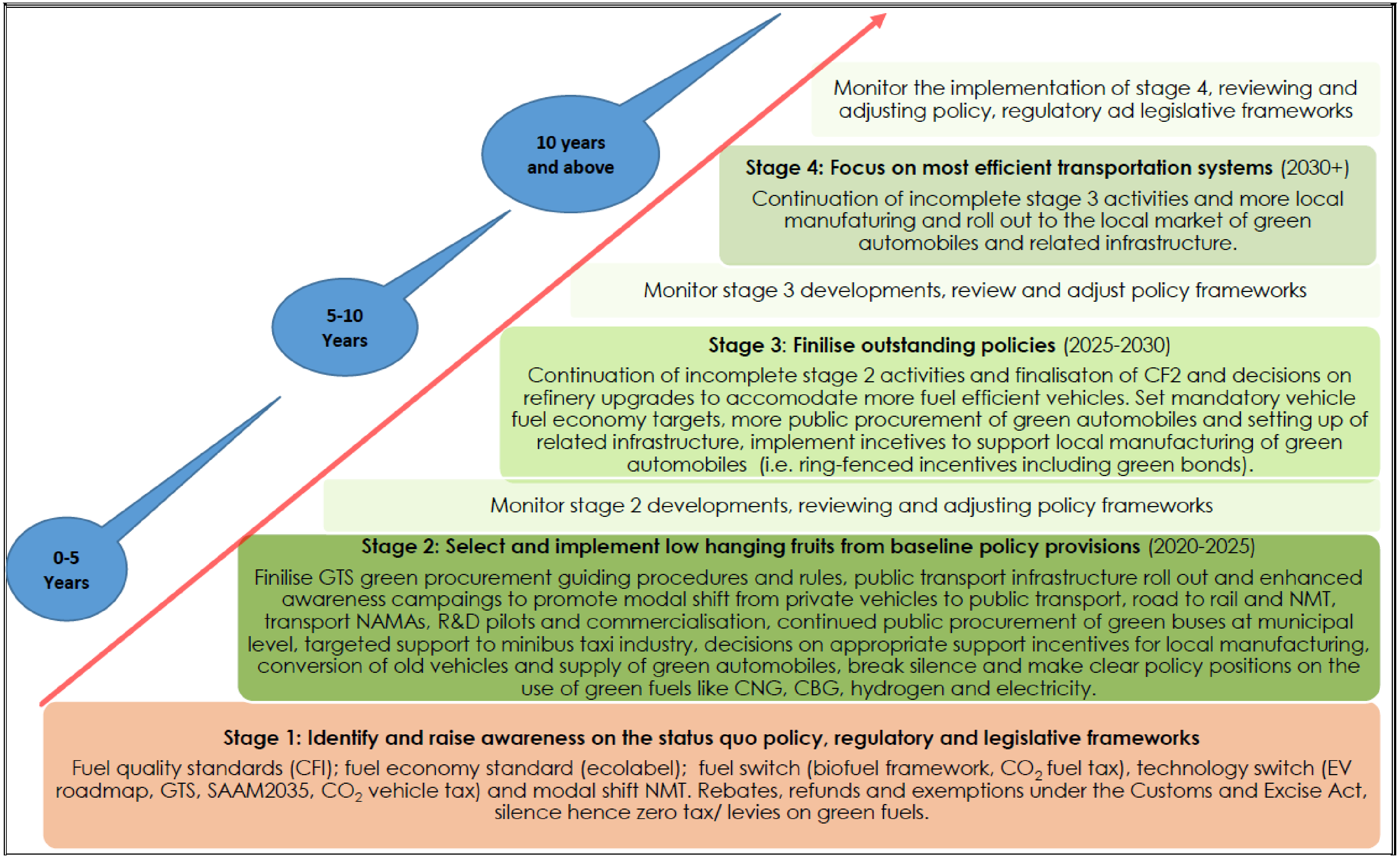

Figure 7.4: Green transport policy directing roadmap model (by author based on literature review and research findings)

7.5.4. Stage 4: Focus on most efficient transportation systems (2028+)

This stage involves more local manufacturing of green automobiles and related infrastructure, and more roll-out to the South African market. It must be noted that, in between these stages, a series of monitoring, review and revision exercises should be incorporated.

7.6. CONCLUSION

Using six major sub-headings: cleaner fuels (fuel quality), fuel economy, alternative fuel and vehicles, modal shift and non-motorised transport, this chapter compared the South African transport greening policy landscape with that of the rest of the world. It also compared the incentive mechanisms adopted globally, thus benchmarking South Africa's mechanisms against the incentives adopted elsewhere. While the world experiences were discussed from a regional perspective including the European Union, Asia-Pacific, Latin America and North-America, specific country cases within these regions were used to highlight the arguments. Examples include the USA, China, Brazil, Russia, India, Japan, Philippines, the European Union, Zimbabwe and Mozambique, to name a few. As a developing country, the trend in South Africa in terms of policy frameworks resembles that in other developing countries, where visible policy provisions seem to favour biological fuels. Examples here include India, Indonesia and Philippines. The rationale for promoting specific transport greening policies and technologies in such countries are diverse, with the socio-economic drivers, mainly employment and rural development playing a critically important role. The drivers in the developed world countries seem to differ, with policy frameworks driven largely by the desire to reduce CO_2 emissions as well as to maintain fuel supply independence.

There is, however, a noticeable attempt in South Africa to follow international best practice, demonstrated by this country's efforts to adopt EU emission standards aimed at reducing tail pipe vehicular emissions. South Africa is indeed lagging behind, with most countries studied having successfully migrated beyond Euro 2 (the current fuel specification used in SA). South Africa's attempts have also progressed to a point where international standards targeting fuel economy are being adopted, however more work is required since no tangible real fuel economy targets have been set.

South Africa is also lagging behind with respect to legislative frameworks to promote alternative vehicles and fuels. There is a huge difference in terms of transport greening incentives offered here and where other countries (notably from the developed regions) have adopted incentive measures that actively promote alternative vehicles and fuels. They have targeted both manufacturers and consumers of green transport products (fuel and vehicles). While the use of subsidies has been widely criticised, when applied carefully, they have proved to be effective, especially in the short to medium terms, where after they need to be replaced by more supply targeting tools such as those employed in California, China and Brazil. It was therefore argued that South Africa can learn from these experiences.

While examples of transport greening incentives exist in South Africa, in most cases “legislative silence” coupled with “incentive silence” has dominated this country’s strategy. This laissez-faire kind of approach seem to have driven the greening initiatives observed in this country’s market, e.g. the use of unregulated CNG in the automobiles. In other words, South Africa has adopted a rather passive stance when it comes to promoting the roll-out of a green fleet in the market. This is evident in the difference in numbers when comparing South Africa with the rest of the world. The absence of legislative provisions and incentive mechanisms that are specifically designed to promote transport greening could explain South Africa’s small number of green fleet reported in the previous chapters, when compared with the number of green fleet reported in other countries. For example, China sold over 640 000 new electric vehicles in 2017, while South Africa sold less than 500 since the industry took off three to four years ago. China had about 6 million NGVs in 2018, while South Africa had about 1000 in 2018, the majority of them being converted minibus-taxis.

The uncertainties that come with South Africa’s laissez-faire approach have attracted a number of criticisms which it is argued here need to be addressed if this country is to see real progress as reported in other parts of the world. One unique feature of South Africa is its historical legacies which have to be factored in, when attempting to help the country transition to green transportation. The South African policy and decision makers sometimes have to make a choice between incentivising measures to green this sector or measures to ensure that people living some 20-30 kilometres away from work, can get home safely and in the most cost effective manner. These are real and unique challenges facing South African transport sector greening decision makers.

CHAPTER EIGHT

SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1. INTRODUCTION

This chapter presents a summary, conclusion and recommendations of the research presented in the preceding chapters. It presents a summary of the process followed to collect, analyse and present the data. Used interchangeably with the concept of sustainable transport or ecomobility, green transport in this research was regarded as a sub-component of *green economy* – a concept pronounced by the South Africa's Department of Environmental Affairs as a path to sustainable development. This country was hence deemed to be in transition to a transportation era that is based on addressing the relationship between the natural ecosystem, social development and economic growth. The world, especially in the developed (core) regions, has embraced the ideology of a greener transportation era, with more work required in the developing (semi periphery) and the underdeveloped (periphery) regions. South Africa was portrayed as a semi peripheral country whose efforts to green the country's transport sector are greatly influenced by developments in the core countries. The research aimed at providing an insight on the South African Government's policy, regulatory and legislative framework responses to green transportation, with three objectives used to achieve this aim.

The idea with the first objective was to explore and describe the status quo in terms of how current frameworks address transport greening. The focus was on soliciting drivers and synergies between these frameworks as well as gaps requiring intervention on the part of Government and other players. The second objective sought to explore views on the current regime relating to transport sector greening and the desired policy direction. The idea here was to solicit people's views, perceptions and ideas, with the hope that these would assist in developing meaningful recommendations on future policy direction. The third objective involved combining the first two objectives to discuss and summarise the findings of the research. In the process, South Africa was compared and contrasted with regions seen as leaders in rolling out green transportation initiatives. It was hoped that this objective, together with the first two, would help in developing a model to inform future policy direction in transport sector greening in South Africa. The aim and objectives were addressed in eight chapters: Chapter One: Background; Chapter Two: Literature review; Chapter Three: Conceptual framework review; Chapter Four: Research methodology and design; Chapter Five: Legislative and policy review; Chapter Six: Views on transport greening; Chapter Seven: Discussion and comparative analysis of South Africa versus the world and development of a model to inform policy direction. This final chapter summarises these seven chapters of the thesis while also presenting brief recommendations on potential research areas in the green transportation field. It is structured as follows:

Introduction (current section), Section 8.2 (summary of each of the seven chapters), Section 8.3 (research contribution to the green economy body of knowledge) and Section 8.4. (Conclusion, research gaps and recommendations). Recommendations on how gaps identified can be addressed in further research projects are provided here. Recommendations on potential policy interventions have already been provided in the previous chapter (Chapter Seven), which also presents a model to inform future policy direction in the area investigated.

8.2. SUMMARY OF CHAPTERS

The eight chapters that make up this thesis are shown in Figure 8.1 below: Background; Literature review; Conceptual framework review; Research methodology and design; Legislative and policy review; Views on transport greening and the Discussion which first compares South Africa with the world, after which a model to inform policy direction is presented.

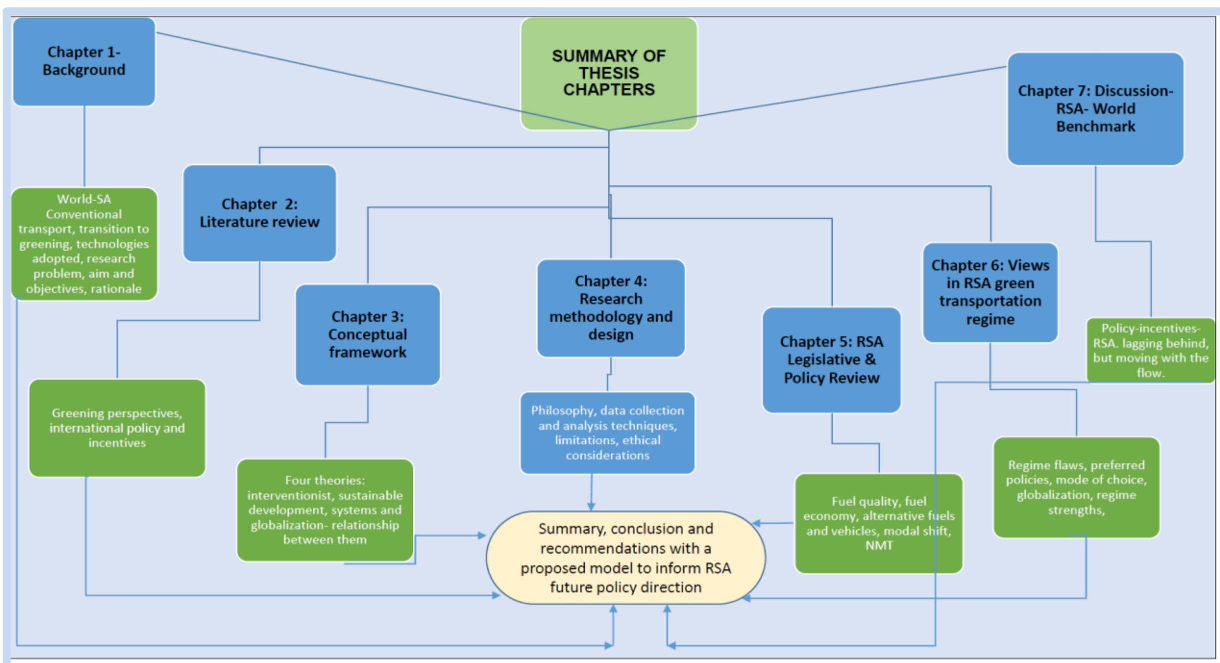

Figure 8.1: Summary of chapters (by author)

The current chapter provides a summary of the thesis findings, illustrating research gaps and making recommendations on potential future research projects. Starting with the background chapter, it recaps key issues and concepts addressed in each of these chapters.

8.2.1. Chapter One: Background

This chapter introduced the reader to the study aim and objectives, the rationale and some history on conventional transportation through to the transition to the focus of this study – transport greening. To set the scene, a brief discussion of the status quo in terms of the world and South Africa's experiences of transport greening were addressed. These relate to fossil fuel-based conventional transportation and the related impacts of this sector on the socio-economic and environmental pillars of the world. With reference to the South African context, the industry value chain and various modes of transportation were introduced. These include the bus, coach and road freight sectors, the minibus-taxi industry, Government fleet and airport handling sub-sectors as well as the private passenger and fleet owners. Since these fleets still rely on the conventional fossil fuels such as petrol and diesel, a number of adverse impacts associated with these fuels were also covered in this chapter. These include tail pipe gaseous emissions which impact adversely on human health and climate change. These vehicles are also very fuel inefficient compared to those used in other developed world countries, particularly the European Union. This therefore leads to South African fleet owners incurring more costs, and the country having to import more, hence impacting adversely on the country's Gross Domestic Product and trade balance.

To address the challenges associated with the conventional sector, South Africa seems to have joined the global bandwagon and piloted a number of transport greening technologies, which were also presented in this chapter. Electric vehicles, biofuel powered vehicles, hybrid vehicles, gas powered vehicles and fuel cell powered machines have since been added to the fleet, however in comparatively small numbers. This chapter also examined experiences of other global players, where green vehicles are now available and used in larger numbers. Fuel efficient vehicles in these countries seem to be the norm compared to what is happening in South Africa. Instead, South African automotive companies produce these vehicles mainly for the export market, since they cannot be used here due to the power quality fuels still used here.

After describing the conventional and alternative vehicles and fuels status quo in South Africa and abroad, the chapter presented the research problem statement, followed by the rationale and finally an outline of all chapters. This chapter was important in providing baseline information to assist the reader with understanding the context of subsequent chapters, hence laying a foundation for these chapters. A picture of the South African transportation sector was developed, and with reference to international cases, this clearly demonstrated how far behind South Africa is in the transition to a green transportation era.

8.2.2. Chapter Two: Literature Review

Chapter Two provided a literature review of green transportation, focusing on two areas considered critical towards addressing the research objectives pertaining to the perspectives/ worldviews on green transportation and the type of policy, regulatory and legislative approaches adopted at global level. These review themes sought to address the first and second objectives introduced in Chapter One.

8.2.2.1. Literature on greening perspectives

The first part of the chapter reviewed literature on green transportation worldviews. The use of the term ‘greening’ in this research denotes a particular response to the shortcomings of the conventional transportation regime. Explained in economic terms, drivers to this transition respond to the negative externalities associated with the use of fossil fuels. A shift in paradigm is needed, which is not without challenges. Some of these challenges relate to the definitions assigned to green transportation. Green transportation is used interchangeably with eco-mobility, sustainable transport, low carbon transport (LCT), clean transport, amongst others. It is the researcher’s view that these terminologies were developed within specific contexts to fulfil particular goals. There is not a single “one size fits all” definition, with authors like Zhou (2012) noting the challenges that this reality poses on the review of existing literature. Nonetheless, the literature on green transport views/ perspectives reviewed in this chapter was used to inform the data presented in Chapter Six, which addressed the second objective of the research.

There was also an attempt in this section to explore the ‘mother phrase’ of “green economy”. Concepts such as anthropocentrism and ecocentrism, often used in environmental sciences, were examined. Also, concepts like free-enterprise economy, Keynesianism as well as neoliberal economy, as often used in the economics discipline were introduced. It was argued that the interaction between the environmental and economic ideologies has to a large extent played a significant role in the kind of transport greening decisions taken at international levels, and as such has implications for the kind of decisions that South Africa has taken or is to take moving forward.

8.2.2.2. Literature on policy approaches

The second part of the chapter reviewed literature on policy, regulatory and legislative frameworks governing transport greening. It focused on international cases studies, dividing the world into five regions: Latin America, North America, European Union, Asia-Pacific and Sub-Saharan Africa. The frameworks reviewed are deemed to have assisted greatly in facilitating a transition to greener transportation in these regions. This part of literature reviewed relates to and hence informs the data presented in Chapter Five, and addressed the first objective of this research provided in Chapter One. The countries designed policies that sought to achieve a number of objectives such as fuel-efficient vehicles and greener fuels. Within the developed regions, drivers differed, where in the European community, the desire to reduce carbon dioxide emissions and to provide cleaner energy appeared to be the major drivers behind measures adopted. In North American countries, especially the US, drivers were largely related to air quality improvement and security of energy supply. Drivers in countries located in Latin America and Asia Pacific seem to be influenced by developmental aspects, including rural development, security of supply and the reduction in imported fuels. Further to their own policy frameworks, developing regions also adopted policies that resembled those of the developed regions. Examples include the fuel specifications/standards, where most specifications are either of European Standard or American Standard formats. In addition to the policies, countries in the developed regions devised demand and supply targeting incentive measures to support further deployment of such policies. These measures assisted greatly in bringing about the green transportation technologies known today.

The chapter also examined policy experiences in Sub-Saharan Africa as well as related research conducted in South Africa. Lessons from this chapter are that despite the existence of a multitude of worldviews about transport greening, success in countries has been stimulated by development of legislative, policy and incentive mechanisms, actively promoting transport greening initiatives. While the socio-economic conditions and drivers differ between developed and developing worlds, lessons from early experiences can be used to facilitate a transition in the developing countries, in a manner that addresses country-specific conditions. Researchers of globalisation theories tend to simply divide developed and developing regions into the core and semi periphery. The following sub-section provides a summary of theoretical frameworks discussed in Chapter Three.

8.2.3. Chapter Three: Conceptual Framework Review

This chapter also reviewed literature but focused on the theoretical frameworks, which were deemed relevant in this research. A variety of frameworks exist depending on the context, with the choice depending on the aim and objectives of the phenomenon being researched. This chapter reviewed four conceptual frameworks, namely: interventionist theories, systems theories, sustainable development theories as well as globalisation theories. Transport greening as a sub-programme of the green economy movement, has much in common with sustainable development. They have a particular interest in finding solutions to correct the market failures of the conventional economic (and in this case, the transportation) systems. Such market failures as described in previous chapters include environmental pollution (tail pipe emissions of CO_2 and other noxious gases), balance of trade deficit and energy insecurity.

Described as a semi-peripheral country, South Africa adopted these internationally driven concepts and globalisation theories as well as systems theories are relevant here. Decisions taken at international levels for the world’s transitioning to green, lock South Africa into them.

Through competition, coercion or emulsion modes of information diffusion, South Africa adopts the culture, ideologies, technology, science and politics of the world. In the process, the world gains by investing in South Africa, selling certain green products and extracting resources for their own benefits.

These four theoretical frameworks were chosen for their ability to answer various questions pertaining to the green transportation study. While the first two theories (interventionist and systems) were chosen for their ability to answer the 'what' questions, thereby allowing better description of the phenomenon, the other two (sustainable development and globalisation theories) were used specifically for their ability to answer the 'why' questions. This allowed explanation of the rationale behind the greening route adopted in South Africa. The relationship between these theoretical frameworks was considered important in that, on the one hand, the status quo could be described, while on the other hand, the reasoning behind the status quo could be explained. Here, the author both apply the theories for improved understanding, while at the same time generate new conceptual ideas likely to contribute to the green economy body of knowledge. This therefore relates to the Methodology and Research Design chapter discussed in the following sub-section.

8.2.4. Chapter Four: Research Methodology and Design

This chapter described the methods that informed the formulation of the research aim and objectives, data collection and analysis through to the presentation of findings. It presented the theoretical as well as the practical aspects of the research process followed by this study. Borrowing from the renowned onion model developed by Saunders et al. (2009), the chapter described the philosophy adopted in the research, followed by the research approach and research strategies. While the approach followed a predominantly qualitative route, overall the approach can be described as mixed methods in that both qualitative and quantitative methods were used, the latter especially in data analysis and presentation. Specific strategies discussed include the case study approach, ethnography, content analysis and archival analysis. These were applicable in different settings, e.g. ethnography for participant observation tool, archival analysis for document review of policy/ legislative framework.

8.2.4.1. Data collection

The chapter described the methods used in collecting and analysing the data, clarifying the difference between primary and secondary data sources, as well as the methods used to collect and analyse such data. The dominant tools used to collect primary data were participant observation and in-depth interview guide, where a total of 17 people were interviewed. An initial sample of between 23 and 35 people had been targeted, however due to some institutions not being available for interviews, this was supplemented with the use of data collected at various events and meetings attended by the author as a participant observer. Data collected this way was used mainly to address the second objective of the research. Secondary data in the form of policy, regulatory and legislative frameworks (local and international) as well as official reports were also collected, reviewed and used to complement the primary data.

8.2.4.2. Data analysis

The main methods that were used to analyse the data were content and document analysis techniques, with the first method used mainly to analyse primary data from the in-depth interviews as well as secondary data from the official reports. The process involved data transcription, sanitising, coding and generation of categories, with a total of over 39 codes reduced to eight major categories. With most data being qualitative in nature, people's views were often presented in direct quotation format.

Policy documents were analysed using document analysis techniques from categories that emerged from literature review. The six major categories include cleaner fuels, fuel economy, fuel switch, technology switch, modal shift and non-motorised transport. The study encountered a number of challenges/ limitations, and these were also discussed in the chapter. The mitigation strategy included triangulation to address sample deficiencies. The chapter also addressed the methods used to ensure compliance with the university ethical requirements.

8.2.5. Chapter Five: Legislative and Policy Framework Review

This was the first of the two chapters that presented study findings. It addressed the first objective of the study which was: *Evaluation of policy, legislative and incentive regime governing transport greening in South Africa, highlighting the drivers, synergies and gaps.* It used six categories identified from the literature review: cleaner fuels, vehicle/fuel economy, technology switch, fuel switch, modal shift and non-motorised transport. These define the greening parameters focused on in this research. The chapter hence evaluated 39 South African policy and legislative documents, which included the Acts of Parliament, regulations, bills and standards. Strategy documents as well as action plans were also examined. These frameworks are scattered across various departments including those responsible for finance, trade and industry, environment, energy, transport as well as science and technology. As such, their original purpose was not necessarily oriented towards environmental protection. Using the six categories, the policy frameworks were evaluated in terms of the manner they referred to or did not mention any aspects relating to the six transport greening categories. In these documents, transport greening topics were searched for, extracted and deliberated. In the evaluation of policy and legislative documents, the strengths and weaknesses of each policy document were extracted and described under each of the six categories. Of interest in this chapter are the strengths and weaknesses shown in Table 8.1 below, which relate to technology switch.

Table 8.1: Barriers and strengths to technology switch

Barriers to technology switch	Strengths to technology switch
❒ High import duties on complete green cars	❒ Relaxed trade on green automotive components.
❒ Ad valorem excise duty on green cars	❒ Abolishment of import duties under the TDCA
❒ Rigid application/ or misinterpretation of finance and procurement	❒ Rebates and refunds of Customs Duties on automotive products and components
❒ "Heavy" subsidisation of conventional automotives	❒ Environmental levy on CO_2 emissions of fuel inefficient vehicles
❒ Requirements for vehicle homologation	❒ No rules prohibiting conversion of vehicles to green
	❒ Green Technology Special Economic Zones (SEZs)

The strengths and weaknesses in this table relate to technology and fuel switch categories. and illustrate South Africa's legislative and policy provisions relating to transport greening. These however often counteract each other, hence leading to no impact. Also noted is the lack of a "killer" or "make it happen" provision – some kind of punch that will lead to massive demand stimulation and hence a notable uptake of green transport goods and services. This provision does not have to last forever, as was discovered from lessons in developed countries presented in Chapter Seven. It was revealed in this chapter that "killer punch" policies and programmes have a lifespan. The strengths in Table 8.1 relate to technology switch, with Table 8.2 below providing a summary of experiences with respect to fuel switch. It was also noted that alternative vehicles such as electric vehicles and fuel cells can only be referred to as zero emission vehicles if they use renewable sources of fuels. Even though this name does not qualify them from a value chain perspective, at least if they use these low carbon fuels, they are comparatively better than when fuelled exclusively by fossil fuel power.

Table 8.2: Barriers and strengths to fuel switch

Measures prohibiting fuel switch	Measures promoting fuel switch
❒ Promising but yet incomplete legislative framework to incentivize use of bio-derived fuels	❒ Rebates and refunds on biodiesel
❒ Fuel levy imposed on green fuel (biodiesel)	❒ No fuel levy imposed on green fuels

❒ Value Added Tax (VAT) imposed on green fuels	❒ RAF – not imposed on green fuels
❒ Import duty imposed on green fuels from Mercosur and General member states	❒ No duty on green fuels from EU and EFTA
❒ Gas not yet declared as an energy source for vehicles	❒ No Customs & Excise Duty on cleaner fuels
❒ Promising but incomplete legislative framework to incentivise use of bio-derived fuels	❒ Carbon tax indirectly incentivising use of alternative fuels
❒ Fuel levy imposed on green fuel (biodiesel)	❒ Electricity legislation providing viable but yet complicated provisions
❒ Value Added Tax (VAT) imposed on green fuels	

Another barrier discussed in Chapter Five relates to the fuel economy standards as well as the emission standards, as South Africa claims to be Euro standards compliant. South Africa's fuel economy standards do not have specific targets, only the compulsory eco-labelling. This provides no incentives to the producers to manufacture fuel economy friendly vehicles. It should be noted that this is a critical policy ingredient, deemed to be driving a transition to a low carbon transportation economy in the European Union. It is driving the initiatives for research and addition of alternative fuels and vehicles in these countries. It was hence on the basis of these strengths and weaknesses that the policy recommendations made in Chapter Seven were made in order to assist further greening of the country's transportation sector.

8.2.6. Chapter Six: Views on the South African green transportation regime

This was the second of the two findings chapters. This one aimed at addressing the second objective, which sought *to explore views on the current regime relating to transport sector greening and explaining the desired policy direction*. The idea here was to solicit and examine people's views, feelings and attitudes on the current Government approach to transport greening. Views included those related to the kind of policies in place, the programmes, the strategies and any initiatives undertaken by Government. These findings intended to supplement findings on legislative and policy review presented in Chapter Five. These were people's views on the status of South Africa's current policy regime with respect to transport sector greening. In this chapter, some categories that attracted smaller numbers were grouped together and discussed under one theme, whereas those raised many times, were discussed individually. The *green transport regime flaws* attracted a relatively larger number of views. Most of these were direct responses to an open-ended in-depth interview guide, where most questions had been informed by the literature. They also include views reflected in policy documents that were evaluated as a complementary tool to the interview guide. Using specific categories (themes), views were discussed and illustrated using graphs. Different views were raised, with some relating to the country's regime flaws and strengths. Some of these aligned well with the weaknesses identified in policy review document presented in Chapter Five. The only difference here is that the flaws in this chapter were identified by other officials in Government and in the private sector, whereas the flaws in the policy review chapter were literature driven. Chapter Five however raised more Government or regime flaws/weaknesses than had been found from the review of policy documents. These findings complement each other. Issues of lobbying, too much subsidisation of the status quo, lack of coordination, competing priorities and lack of revenue ring-fencing, were common issues raised by the respondents and found in the policy document review. This was also true for the funding of green projects and availability of policy strengths, as these appeared from both findings, hence attesting to the power of the triangulation method described in Chapter Four.

While the views were presented by individuals, these individuals represented the organisations they were serving. While their views could be aligned to the official positions of their institutions, it is likely that they were their independent views as well. From Chapter Four, it should be remembered that the participants were purposively sampled and chosen if they held senior positions within their institutions. They were therefore at the heart of policy making within these institutions. As such, it was believed that their views were significant, and hence could be considered and where possible incorporated into the recommendations for policy direction presented in Chapter Seven. Lack of coordination, as a dominant flaw raised in this chapter, points to systems challenges in Government, which requires specific interventions. Each department can be viewed to be 'doing its own thing', and this is a cause for concern, especially in the context of transport greening being described in the literature as a multidisciplinary area requiring efforts from all relevant parties.

8.2.7. Chapter Seven: Discussion and development of model to inform policy direction

The main aim of this final chapter was to provide discussion on the two findings chapters Five and Six, thus addressing the third objective of the thesis, by rigorously comparing and contrasting South Africa with other countries throughout the world. The analysis was twofold: i) comparison of views on transport greening, and ii) comparison of legislative and policy frameworks based on six categories: clean fuels, fuel economy, fuel switch, technology switch and to a lesser extent, modal shift and non-motorised transport. South Africa was compared and contrasted with the 'advanced' countries in terms of transport greening policy provisions and general government environmental support programmes. It was revealed that South Africa is indeed lagging behind in most aspects. While policies promoting the use of improved quality fuels exist in South Africa, the fuels powering the vehicle fleet are still comparatively of low quality, hence locking the country into continued use of fuel inefficient vehicles. South Africa has clung onto Euro 2 equivalent fuels, while other countries have slowly migrated beyond this to cleaner and more efficient fuels. Furthermore, the world has set targets for a fuel economy, while South Africa is once again lags behind with no specific fuel economy targets. Setting such targets in the developed world has assisted with improving not only efficiency of the Internal Combustion Engine (ICE) vehicles, but also the diversification of automobiles to include alternative vehicle and low carbon fuel technologies.

Regarding alternative fuels, biofuels in South Africa received partial attention, with other alternative fuels such as compressed natural gas and electricity, receiving extremely minimal to zero attention. The same has been true with the use of alternative vehicles, where most projects involving the procurement of electric and gas powered vehicles have been undertaken at local government level. At Research and Development (R&D) levels, hydrogen fuel cell technology is receiving some attention, however with more focus being placed on electricity generation than on vehicle usage. South Africa's stance has been "silence" or very minimal interventions in the form of direct funding of green transportation projects. While attempts have been made to actively promote biofuels through the development of customised incentive mechanisms, this exercise has proved to be futile, as no incentive mechanism has been developed since 2014, when this process was initiated. In contrast, the world leaders in alternative fuels and vehicles actively promote these technologies through specific demand and supply side financial and non-financial incentives, including tax credits, tax exemptions/breaks, direct subsidies, R&D investments, to name a few.

The second part provided a comparison between South Africa and the world contrasting perspectives around transport sector greening. The manner in which South Africans viewed and understood transport greening was compared with literature views on this topic. Many flaws were identified in the South African context, with greening defined mainly in environmental terms, something which the author argued, has a global influence. This is, however, not always the way transport greening is defined in the world. Even though no standard definition exists, there is consensus over the need to incorporate all three pillars of sustainable development in this definition. This includes social, economic and environmental pillars. The chapter presented a series of possible policy interventions, followed by a model designed to inform the direction of transport greening in South Africa.

By virtue of South Africa being a developing country, comparison with more developed countries may seem unfair but the intention was to locate this country on the world transport greening map and draw lessons from the exercise, which could then be used to assist in redefining and/or remodelling the country's future policy direction, discussed in the following section.

8.3. CONCLUSION AND RECOMMENDATIONS.

This research provided a review of transport greening approaches in South Africa, focusing on the actual landscape around the policy and legislative framework of the country's transport greening regime. These frameworks were compared and contrasted against the frameworks in select countries from the European Union, Latin America, Asia-Pacific, North America and Africa. The research also examined local perspectives on transport greening, comparing and contrasting these against the views raised by experts, authors and other players at international levels. While this country views transport greening as a path to sustainable development, the many diverse definitions and views assigned to this path contribute to the difficulty associated with efforts to promote and implement solutions. In a country like South Africa where democracy is still nascent, the legacy of apartheid spatial planning prevails and competing priorities of national importance still exist; these factors contribute to the status quo and thinking around transport greening. South Africa is characterised by many socio-economic and spatial challenges which include low density areas (as a result of a formalised separation of residential from work areas), high levels of unemployment, high energy costs associated with importation of liquid fuels and intensive use of subsidised conventional fuels and automobile technologies. These same fuels and automobiles have contributed their share to undesired emissions hence impacting negatively on human health and global climates.

Transport greening, as a response to the environmental and socio-economic challenges and as a path to sustainable development, has given rise to many initiatives in the private sector, academia and public sector institutions both in South Africa and abroad. Also, a number of research projects have been conducted in this area, with most findings in South Africa pointing to the lack of a coordinated and disintegrated approach as one of the most prevalent deficiencies deterring progress. It was argued in this research that such deficiencies were brought about by many factors including the diverse nature of transport greening activities where policy and legislative mandates are cross cutting between various organs of state. South Africa has made provisions in various policy and legislative documents which have implications for transport greening. The goals and objectives of such frameworks however are informed by many drivers, which are not necessarily 'green', but rather fitting the goal and objectives of particular departments. Examples were cited in Chapter Seven around how the CO_2 levy is used as a 'camouflaged behaviour changing tool' to discourage use of fuel inefficient vehicles, when the real intention according to this research, is revenue collection. The high import tariff on green automobiles and the associated Ad Valorem duty on electric vehicles, are unjustifiable policy positions as they hit hard on the demand for these green automobiles. South Africa's approach to transport greening therefore appears to be dominated by elements of fragmentation, less coordinated approaches, lack of policy frameworks and incentive mechanisms that actively promote demand and/ or supply for specific transport greening initiatives. The policy frameworks and enabling incentive mechanisms were cited as major tools that assisted the developed world countries to actively stimulate demand and supply for transport greening goods and services. Compared to major global players, South Africa was deemed to be lagging behind, but slowly joining the international bandwagon towards the adoption of transport greening best practices.

The research also pointed to the existence of many vested interests in and outside the borders of this country, with these interests having an influence on the status quo, and probably the future of this country's transportation industry. While South Africa is usually described as comprising three spheres of governance, this research noticed the emergence/ existence of the *fourth sphere of governance* (the international). Presented in globalisation theories as the core countries, this region has played a noticeable and influential role in South Africa's transition to green transportation. This country's transport greening model was hence explained using globalisation theories of information diffusion which argues for either coercion, simulation or competition as the main driving force behind South Africa's greening efforts. Many examples were cited to clarify this argument, with South Africa's adoption of the EU standards for vehicular emissions and fuel economy, being one such example.

South Africa needs to respond better and improve the status quo in this transition. As such the initiatives (technical and policy-wise) already undertaken in South Africa put this country at an advantage, even though some of these initiatives (such as the Joule car) have since been abandoned, discontinued and forgotten. Thus in the policy recommendations in Chapter Seven, it was stressed that South Africa does not need to start the process from the beginning. Instead, a recommendation to make use of the 'low hanging fruits' using the existing policy provisions was deemed to be a good starting point. Also the enhancement of existing, but less conducive policy provisions, is another starting point. A series of policy recommendations were made in Chapter Seven, with a policy directing model also developed to assist the transition. From this model comes a recommendation for the establishment of an institution/ structure that will impartially coordinate the development, improvement and implementation of custom-made transport greening policy frameworks and incentive mechanisms. The current structures are biased towards their constitution-enshrined mandates, and as such they are not the best to coordinate transport greening. It is not the Department of Transport, the Department of Trade and Industry, the Department of Energy nor the Department of Environmental Affairs, or any of the existing structures that can coordinate transport greening efforts without bias. This is due to the multidisciplinary nature of transport greening in this country, where the existence of these many layers, often with conflicting interests, have inhibited transport greening outcomes thus far. This proposed centralised and impartial policy and programme implementation structure / institution can be made up of representatives from various institutions with transport linked policy mandates. Through multi-criteria/multivariate decision making tools, these representatives can prioritise and facilitate various green transport sector related policy and programme activities. As a starting point, this task can be allocated to the country's department responsible for monitoring and evaluation.

To conclude this chapter, it should be noted that even though various research has been conducted in South Africa and abroad around the greening of transport sector, gaps still exist. It was further presented in this thesis that such studies in South Africa, tend to be biased towards specific transport greening modes. The current study attempted to cover most transport greening modes, starting from where the chemical "lead" was banished from the country's liquid fuels through to the promotion of non-motorised transportation such as walking and bicycling. Many gaps still exist, however, hence presenting an opportunity for further research in and contributions to the green economy/ sustainable development body of knowledge. The following list is not exhaustive but offers areas of possible future research in transport greening:

- The impact of various 'behaviour' targeting punitive measures imposed on the transport sector such as the new vehicle CO_2 and the fuel CO_2 levies present an interesting area for future research. It is important to understand if these fiscal tools do indeed achieve their intended objective of behaviour changing, and if they can be used effectively to promote modal shift from use of private vehicles to the use of public transport and non-motorised transportation. More studies such as these are required in order to provide more insights and justification for continued levying of such goods. Otherwise, it is easy to regard these levies as simply another revenue collecting tool of Government.
- The extent to which municipalities have factored in transport greening in their Integrated Transport Plans (ITPs) presents another research area that this thesis did not cover. Such research would solicit motivating factors behind municipal decisions to procure green transport goods, as is currently the case in major metropolitan cities of Gauteng, KwaZulu-Natal and Western Cape. What policy tools did/ do they employ to bring about transport greening initiatives? These institutions are key as they are responsible for the actual implementation of policy and legislative frameworks drafted at national and provincial levels.

- While this research briefly examined transport greening initiatives in the leading green transportation countries, the aim was to compare these and what is happening in South Africa. It did not provide a thorough review of the success and failures of these initiatives. It is important to have this research undertaken, especially in the context of possible simulation of these options as South Africa strives to select the best route. What gets sold by rent seekers and/ or by lobbyists may not necessary be the best route, since certain areas of failure may be withheld and never shared with decision makers.
- South Africa is believed to be well endowed with coal, which Sasol already beneficiates to liquid fuels through the Fischer-Tropsch synthesis process. As a fossil fuel, less focus was placed on coal in this research, hence leading to bias towards alternative fuels sourced from renewable energy. The research did not go deeply to examine developments within the coal industry and the extent to which these developments have contributed to the reduction of well-publicised impacts associated with the use of coal as a transport fuel. A thorough review of current and potential greening opportunities being explored within the coal industry, would be useful.
- There is a need for more research to understand linkages between the green economy transition, green skills gaps and the required curriculum adjustments to align with the transition. This should also clarify linkages between the green economy transition and the 4th industrial revolution (4IR), including enhanced understanding of transport greening modes such as use of smart mobility, use of autonomous vehicles, etc.
- Various exclusions were noted in Chapter One in terms of areas that the research did not cover. These include policy positions regarding the use of green material in the construction of roads, highways and bridges; policies related to land use changes and travel demand management as well as the marine and aviation industry green responses. While these were excluded purely to reduce the research scope, they present opportunities for future research.

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APPENDIX A:
COPY OF ETHICAL APPROVAL

UNISA university of south africa

CAES RESEARCH ETHICS REVIEW COMMITTEE

National Health Research Ethics Council Registration no: REC-170616-051

Date: 14/10/2016

Ref #: **2016/CAES/088**
Name of applicant: **Mr PG Ninela**
Student #: **58548580**

Dear Mr Ninela,

Decision: Ethics Approval

Proposal: Towards sustainability in the transport sector: A critical review of South Africa's regulatory responses to transport greening initiatives

Supervisor: Dr M Togo

Qualification: Postgraduate degree

Thank you for the application for research ethics clearance by the CAES Research Ethics Review Committee for the above mentioned research. Approval is granted for the project, *subject to submission of the relevant permission letters.*

Please note that the approval is valid for a one year period only. After one year the researcher is required to submit a progress report, upon which the ethics clearance may be renewed for another year.

Due date for progress report: 31 October 2017

Please note point 4 below for further action.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the CAES Research Ethics Review Committee on 13 October 2016.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and*

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principles expressed in the UNISA Policy on Research Ethics.

2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the CAES Research Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*
3) *The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.*
4) *Only the permission letter from the Department of Trade and Industry has been submitted. The permission from the other targeted departments must be submitted to the Committee before data collection may commence at these departments.*

Note:

The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the CAES RERC.

Kind regards,

Signature
CAES RERC Chair: Prof EL Kempen

Signature
pp CAES Executive Dean: Prof MJ Linington

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APPENDIX B:
IN-DEPTH INTERVIEW GUIDE

A. Green transportation- **what is your understanding or views on this topic?**

B. From your own perspective, **is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

C. Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: **what are your views on these developments?**

D. If you were to render advice to the South Africans in terms of the best technology for the country, **what would be your recommendations moving forward?**

E. Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, **what are your views on this argument**?

F. If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, **how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

G. Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. **From your perspective, which instrument would you say is required in a country like South Africa, and why?**

H. If you were to recommend any of these instruments to the South African policy makers, **what would be your recommendations?**

APPENDIX C:
INTERVIEW TRANSCRIPTS TO ADRESS THE SECOND OBJECTIVE OF THE THESIS
'Exploration of views on the current regime relating to transport sector greening and explaining the desired policy direction'

INTERVIEW 1 & 2

Meeting with AA and LZ of Gauteng Provincial Department Of Roads And Transport, Date:14 June 2018, , Venue: LIFE Center Building, 45 Commissioner Street, JHB

A. **Green transportation- what is your understanding or views on this topic?**

AA- We are still grappling with the concept of green transport, where it is still used interchangeable with the concept of sustainable transport. The recommendation at Exco level has been that, let us rather get this sperheded/ done by GDARD, not by our department. That the green transport policy should rather fall under the sustainabe development policy, which does not fall within this department's mandate. That, the Non Motorised Transport Policy should then fall under the Green Transport Strategy. At the momet, in Gauteng we have a Grean Transport Policy and a Non-motorised Transport Policy. When we developed the green transport strategy in 2014, the concept was so new to us but also to many people out there. So Non-motorised transport forms a big chank of our GTS. There has been calls from institutions like UNIDO and Sanedi, for us to broaden this concept further, and include small EVs and energy efficient modes of transportation. Transport is avery broad concept, going beyond the boarders of Gauteng. Vehicles come from other provinces and from other countries. This then raises question of how do you regulate such an industry. How can you prescribe what green transportation to these visitors who live beyond our provincial boarders? At the time, policy was very generic, and was silent on green trasportation.

LA- no specific legislation is SA. So enviro provisions in the policy was informed by what is in the international domain. It was informed by international conventions. There is a provision somewhere in our national legislations/ constitution that, if there is no supporting legislation at national level, continue doing your policies based on what is happening at global arena. So, back to the question, our understanding of green transport is about how clean is what we are doing. At the time, there was talk about Euro 4 and 5. Maybe it is time we now review what we did back then in order to keep up with times and what is being done at national level with regards to the GTS.

AA- with lack of policies at national level, a lot was happening at international level. Another is that, sustainability is so cross-cutting, touching on everything. Our approach was that, let us do it introspectively, focusing on things that are within our control as a province. E.g. we started with our G-Fleet, converting it to use biofuels. There was then a social development issue.. accessibility of filling stations. There was also the issue of fuel vs. vehicles. Where do all these come from. Then this brings us to the automotive industry issue. These are all imported. Green transport, initially, is very expensive, but as time goes on it becomes affordable. There is however the issue of levies and ringfencing- National Treasury and the dti. Why should we ring fence and why can't we use the money collected to fund green transportation?. Examples here are the Maringe plant piloted at our Innovation Hub. I still think that, this was a good project. Indeed, there was this food vs fuel project. Most initiatives at the time were severely affected by positions at political levels. Nomvula Mokonyane was the premier at the time, and she seems to have been against the environmental, but rather favouring the social aspects of developments. A statement like, "we can not halt development because of butterfy eggs".

LA- sustainability of the nterventions is important- quality of fuel. So we decided to steer clear in the policy, one thing that we could not do. All the things mentioned by Angela made it difficult for us, e.g. could we say scrap all old cars and never allow them on the roads. Some guy, as an example, who comes all the way from KZN with his old bakkie, to buy things in Gauteng for his business back home, how would you stop such a person from using such a car. Offfcourse you would be impacting negatively on his ability to make a living. So, there is another sersious issue of enforcement. The issue of capacity building, awareness raising and incentivisation then becomes important in this case.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

AA- Our resources- depletion- water scarcity, coal, space (roads)- resources need to be there. Besides that, there is myth vs reality over climate change. The reality though is that, climate change is real. Indicators of such reality are now obvious- the reality is on the wall. People now have a responsibility- human health, deseases. The problem in South Africa is that, we try this, once it fails, we drop it and try something else. What is surprising is that, in Europe, they have shown interest in our minibus taxi industry, and they want to try that model there. Once it is implemented there, our politicians will go there, like it and come back to South Africa, demanding that, let us do it in South Africa. Warrrraa…..we re doing it anyway, but they are not realising it.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

AA- There is so much hype on the part of politicians, when they visit oversees. They see what is being done there, bring back buzz words, and start wanting to implement these things in South Africa. They take a one size fits all approach. The problem is, they do not take the time to see how these ideas or projects worked there, the challenges that were encountered over time in those countries where they were implemented. The best practice for the country would be to let us look back, see what went wrong with the projects we initiated, before giving up and moving on to other projects (this respondent reminded me of the Joule Project). Everything we did before, what went wrong? We can learn from such mistakes. As an example, the BRT.. this is failing, and they have been keeping quite, but slowly they are coming out. There is a grant that they got, as well as a huge loan that has to be repayed to the Development Bank of Southern Africa. The challenge is that, these buses are operating at a loss. The BRT lanes, are not open to the general public transport. But only to the BRT buses, which from time to time, run empty. Instead, the minibus taxis drive on these lanes full. There is thus a need to incorporate the taxis into this system, creating space for them to utilise instead of bloking them/ preventing them from using them. Regarding NMT, large focus was on retroffiting existing roads. But these were erected in roads where people do not need them. In suburbs, people either own and drive their cars or ride buses. Are these the right areas, no. There is not even linkages to areas that have this infrastructure. There are areas where people are doing the actual walking to work. These are areas where NMT infrastructure- cycling lanes in particular, is needed. So, in the province everyone is doing their own things, there are no synergies. BRT is one such a disaster project the country has ever done (this argument was supported by the presentations made at the Competition Commitionin sessions in KZN in July 2018, where heavy criticism of the BRT system was raised unapologetically, however by a private bus association- obviously there could be competition issues here. Nonetheless, as a citizen in one of the large metros in SA, from time to time, I witness these buses driven empty on the BRT lanes, so there is validity in the statement mde by this respondent).

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Not covered- but look for reponses in A, the answer ould be there.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Same as above in D

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Same as above in E

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

AA- Rather incentivise- provide awareness and training first. Then go for the carrot approach first before taking any punitive measures. Look for the 2016/2017 household travel survey that was done with stats SA. Like me, I am still keeping an old gas guzzler, the 1996 nissan bakkie. It is so old that it does not tell you how much you are consuming, but the BMW car I own now tells how much I am consuming at what speeds, etc. so the point is, it is all about awareness raising about the cars we buy. As consumers we can make better choices if we are informed. This talks to enforcement- which should not be limited to the man on the uniform (police?), but you, yourself , through the use of appropriate technologies, can enforce compliance with the right transportation systems (Link this to the fuel economy standards). Regarding the tools (subsidies, taxes and regulations), we need a combo of instruments. The consumer is already hardest hit. We need grants, where ringfencing can play a major role. Our problem is that we are creating a reliant society… e.g. we have grants that cater for the scholar transport. The transporters are subsidised, but there is too much cross-subsidisation already happening in this country (this again links to the presentation made by Wosiane in the Competition Commisison session in Durban I July 2018). There are students and old age pensiners who obviouslly benefit from BRT, SASSA, Metrorail and PRASA in terms of subsidisation- I am not anti-old age, but this is the example of cross-subsidisation I am talking about. **LA-** It is important for the country to take a good approach. Study the tool carefully before implementing it. One needs to ensure that the tool adopted will produce sustainable resuts (Link this to the intervention theories, and statements made by other respondents on this issue). Are we putting enough research on a tool chosen, is it the right one?

H. **If you were to recommend any of these instruments to the South African policy makers, what would** be your recommendations?

Not covered- but look for reponses in A, the answer could be there.

……

INTERVIEW 3.

With BK of Department of Transport, at CSIR Convention Centre, Pretoria. 07 June 2018

A. **Green transportation- what is your understanding or views on this topic?**

We need diversification of energy mix- no reliance on petroleum products- petroleum price is the highest in the history of petroleum prices in South Africa. So there is security risk. We need to diversify; therefore, we need more technologies.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Security of supply- oil from the Middle East- most of it, South Africa does not have reserves. So the laws that are meant to protect us, are the ones that are harming us, i.e. fuel levies on petrol, RAF, etc. these contribute to the higher price of fuel we have in the country. DoT is very much driven by GHG reduction.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

South Africa is a developing country. Priorities are heavily focused on job creation. Green Transportation technologies hence need to cater for this area of national imperative. The country is moving towards the right direction; however, we are not a developed world. Market still dictates. Countries like Cuba however managed to run on 50-60-year-old vehicles, and it worked very well. The challenge with our technology is that, it is not innovation friendly. We need to lower the emissions, even if you put sunflower. My view is that, even though all technologies should be embraced, but fuel cells are moving too fast. So not yet, it is still early to chase them at full speed. The drivers are different- fuel cells are chasing beneficiation of platinum.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

In South Africa, we have rural vs urban provinces. We also have peri-urban provinces such as North West. So Policy makers need to sit somewhere in the middle in order to cater for the needs of all these beneficiaries.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

It is true. In SA, we are at an elementary stage. DEA is very strong in lobbying everyone to buy into the climate change story. It is driving the emission reduction issue. The GTS as an example, was influenced by the NCCRP. It emanates from there.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

In Africa, we are number 1. In Kenya, I presented the GTS work and the low carbon economy standards. 40 countries were present there, and after finishing the presentation, attendants agreed that, they are not there yet. Africa committed in the metrology that Climate change should be the main transport sector driver. So, I feel like South Africa is not doing much in combating climate change.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Subsidies vs taxation- we need more subsidies. There is too much tax in the South African system, hence causing a burden to the consumers already, e.g. carbon tax, fuel levies, environmental (emission) tax. Current approach in countries like Germany, provides incentives for technologies such as solar PV. Perhaps, we can consider tax as a punitive measure on people who are still clinging on fossil fuel use. During the GTS development, we had proposed EV charging from solar PV only. However, with the newly built power stations- Medupi and Kusile, we got our hands squeezed to say that the EVs would be charged from this additional capacity from new power stations (this is more like replacing one devil with the other, unless the new power stations are all fitted with state of the art pollution abatement technologies such as flue gas desulphurisation, etc.).

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Was not covered during the discussion- addressed in the input above.

....

INTERVIEW 4.

With MB of the South African Energy Development Institute (Sanedi) on *18 June 2018, Sanedi offices, Stratavon- JHB*

A. **Green transportation- what is your understanding or views on this topic?**

Fuel prices have been going up, with the latest prices being the highest at around R16/litre. That leads to food inflation, high costs of transportation. So as a country we need to create demand for green transportation, mainly the electrification of the transport sector. We need to improve energy security by switching to RE. As a country we experience around R109Billion capital outflow.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Not discussed due to time constraint

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

No, this is not the correct route we are taking as a country. There is quest for competitiveness. That is what investors are looking for. No investor cares about our political history- apartheid and a need to address the previous injustices. They are rather interested in how much more profits we can make out of our investments in South Africa. It is all about profits, efficiencies and competitiveness. Look at the following- Smaller, better or different. What is it that we want as a country? We first need to establish that. In SA, there is an umbilical cord tied to the past. Euro 1, 2, 3 to 6, why should we follow this route? We have to make a decision and choose a path that is unique to us, we cannot always be following while others lead. Electric vehicles? (The respondent was vague on this, not explicitly saying that we have to choose EVs). Whatever you do locally, where you will sell it, what will be your market? For South Africa, storage is the key. It is where we need to get something done. If you take a ***well to wheel*** as an example, you get the following efficiencies:

a. 15% (direct use of petrol/diesel in the ICE
b. 7% (if you follow the Sasol route- Fischer Tropsch)
c. 24% if you plug your EV direct to the Eskom grid
d. 75% if you use renewable energy

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Not discussed due to time constraint

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Transport is not an end to itself. You have to understand everything and we need to understand why we are doing it- it is because we want to move to smart cities. But, regarding that, there does not seem to be a policy to assist the country towards that transition. There does not seem to be support for transitioning to efficient transportation fuels. So, someone must define that future for us, then let us put money to make it happen.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Not discussed due to time constraint.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Funding issue- not a problem at all. The issue relates to strategic direction, that is what is lacking on the part of decision makers. In a nutshell the strategy evolves around the following 3 issues:

a. Product leadership- innovation

b. Operative excellence- operations and supply chain
c. Customer Intimacy- customer service and customer chain

The oil companies are saying, if the country takes that transport electrification route, then why should they do the upgrade of their refineries? South Africa therefore needs to come out and be clear on what it needs to achieve in this space. The question is, why do we continue supporting a sinking titanic? The industry is dying anyway, so why wait for its complete death before we do something (which industry is dying, oil refineries or the ICE industry or both- the respondent did not provide clarity on that, and unfortunately time was running out)

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Not addressed due to time constraint.

Closing remark- how can we be different as a country?

……………………………………………………………………………………………………..

INTERVIEW 5.

With GK of the dti on 06 February 2018 at the dti campus, Pretoria Sunnyside

A. **Green transportation- what is your understanding or views on this topic?**

Transportation using alternative energy, less gas, reducing carbon emissions. Walking and bicycling not considered a green transport. It should rather include public transport, use of buses and minibus taxis instead. Walking is walking, cycling is cycling- riding a horse is riding a horse, there is nothing alternative about those.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

We have to. Policies we make should look at long term situations. There are obviously changes in the environment. There is too much sun and snow in seasons that were not previously like that. So, it is important to use it in a way that does not cause harm to the environment. The challenge however is wanting to green the transport sector when we have not even perfected the conventional sector. When we are struggling to sort out the status quo, how are we going to succeed in changing the paradigm? There are costs involved in changing to the green paradigm. ICE as an example, if we say there is no more need for them, surely we will import less petroleum, but what about the current infrastructure that was developed for this sector. The filling stations, the refineries, and people employed in these sectors? There will be more additional money needed to bring solar charging infrastructure, where will funds to erect this infrastructure come from? We need money for a variety of needs including education, housing. When we are struggling to fund these already, where are we going to get money to go transport greening route?

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

We need to focus. We cannot be everywhere, we need to do what we are good at, what we can use. Let us focus on which ones we have competitive and comparative advantage on and start prioritizing those. If we target all, none will succeed. So try this first, and if it fails move to the next?

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Same as above, but prioritise what costs less first.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

It is true. Green Transport is not an easy task, it is costly and requires some commitment on the part of government. E.g. the RSA automotive sector did not grow without government support. In the 1960s, enabling conditions were created in order for this sector to thrive. Incentives/ subsidies and international agreements allowing SA to export certain vehicle types, were created. Example of Mercedes Benz, the local market is very limited. Most are exported to the affording countries. Also, what we have produced far exceed the local demand, so we have to export more units. The initial strategy was… import, import, import. Then a paradigm shift brought by government was, import substitute industrialization. In other words, import certain components and assembly the vehicle here in the country as opposed to importing everything. The industry will surely say that, we are interested in transport greening, but what does the government have on offer for us.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

We are nowhere in South Africa. No tangible policies on GT. We see ongoing research, it never ends, but no final decisions on the right things that need to be done. We argue about small things like, reduce import duties on EVs. There is lot of engagement though, but these all look like talk shows. Very minute initiatives. Last year, here at the dti, we launched an EV, but what happened to that initiative? If one is that serious, more green fleet would have followed, but what do we have, nothing. What I am say is that, let us be creative, e.g. when booking a pool car, let us be creative. Let us develop a procedure/ policy on the use of the EV pool car by **the dti** community. By the way, what is the plan?

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Policy and subsidies- but what is the difference? To me, by subsidies and taxes is meant the same thing. The money comes from the same pool of funds. e.g. if you bought an e-bus in your fleet, you will not be paying RAF, Levy, so these are the kind of instruments that I believe South Africa needs. You need tax breaks, rebates, etc. It is however not easy to choose one. You cannot choose either tax, policies or subsidies. You better have a combination of all of them.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Same as above in G, but you need things like a very clear trade policy, industrial policy, tax policy, i.e. a mixture of enablers.

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INTERVIEW 6.

With HS of CNG Holdings on 24 August 2018, at the dti Campus, Sunnyside, Pretoria.

This is obviously an industry player, however there could be issues that cross-cut with government, e.g. the application of demand targeting tools such as subsidisation of fuel gas purchases. But also, government role here in the form of financing institutions like the IDC and the Central Energy Fund, taking equity in businesses, cannot be ignored. This probable talks to the "Regime strength" code in the coding scheme in Chapter Six.

- ❒ About 3000 taxis in Gauteng run on CNG- Currently we have about 4 gas filling stations- Dobsonville Soweto, Langlaagte, Pretoria- Marabastaad and Vereeniging. Three more to open soon (Waltloo, Southgate and Sebokeng).
- ❒ Nissan now coming on board, with a deal to have 100 NP350 kombis converted and sold as a full package to customers. Westbank also coming on board to finance these vehicles.
- ❒ Scania- brought their 340 horse power truck… converted at our site and is now running- as a demo to SA (Person there is Mark Templeton) - Scania opposite Soweto.
- ❒ Also ACSA- talking to CNG holdings to have airport vehicles converted to gas. Toyota using CNG converted forklifts, Metro buses in JHB.
- ❒ Now earmarking Richards Bay- by March 2019. Unilever, and the taxi industry.
- ❒ Converted minibus quantum taxis, about 60 liters' full gas cylinder (including container weight) each can run about 350-380 km before next gas filling

- ❒ Phase 2- gas bottles lighter than the current ones. The 4th phase will use bottles which are 15% lighter than the second phase bottles, so efficiency-wise we are improving- all including conversion kits are imported from Europe. The new tanks are rubberized, with the capacity of 250 bars.
- ❒ It takes about 30-45 seconds to switch a vehicle from petrol start up to using the gas. So, you need a few liters of petrol in your tank to start up the engine before the gas can reach the required temperature (i.e. 600 degrees Celsius) to fire the cylinders. You need petrol because it is lighter, and able to burn the gas at low temperatures around 270-300 degrees Celsius.
- ❒ To convert a tax one needs about R20-25 Thousand Rands.
- ❒ To reduce possibility for stealing, the system is fitted with computer box (ECU) which assists in monitoring gas consumption from the time when it was filled.

We provide rebates to the customer and the customer must provide us with a guarantee that at least they will be able to fill about 500liter /month worth of gas in their vehicles.

- ❒ The vehicles are fitted by qualified technicians, and only 4 of them exist in the country. One of them works for us.
- ❒ We provide the gas to hospitals (about 9), mining and industrial sites. BBK in the Free State, Glencore and Exxara biodiversity programme- Villy Van Schalkwyk)
- ❒ Sasol uses LPG to liquid, not CNG.
- ❒ Potential relationship between government and CNG holdings- what about converting G-Fleet. The researcher also explored the possibility of following up to understand the pool car arrangements in his department's fleet.
- ❒ CNG holding initiatives already financed by IDC- have a stake in the business- about 37% equity.
- ❒ Frustration relates to technology not being well marketed in SA. A need to improve on this. Government support is needed. The researcher's surprise was that HS never raised the fuel levy issue (current non-levying and the uncertainty it creates) as a burning issue. Despite his attempt to bring this issue to his attention, he seemed to demonstrate less concerns about the implications of this to his company's sustainability.

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INTERVIEW 7.

Interview with NL of NAAMSA, on 30 July 2018, at NAAMSA OFFICES, Pretoria

A. **Green transportation- what is your understanding or views on this topic?**

Transport greening is an intergovernmental issue. There is need for policy cohesion. Eco-mobility is an ecosystem issue, which should touch on all aspects of mobility such as infrastructure, safety, etc. NAAMSA is an association for global OEMs involved in the import and export of products. We must remember that South Africa is a technology taker, however with Europe as our biggest export destination. So, if as a country we need to keep up with developments that are taking place internationally, what will we do when these customers no longer want our products? This is a consumer driven sector, but yet government. NAAMSA has an alternative fuel committee to assist the association keep up with international developments. Companies in the world are busy with these technologies. Standardisation of charging stations- there are opportunities in this space. The automotive sector is a fully integrated sector. On the EV side, this is still small in SA, but given the fully integrated nature of the automotive industry, SA has to adapt to what is happening internationally. SA is a small player in this sector. NAAMSA committee on EVs advises on what needs to be done in this sector. The major issue for now is refinery upgrade- cleaner fuels in particular. There are practical issues that SA needs to address.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

Industry agencies, academia have done various work in this area. This industry is about volumes; this is an ecosystem. For each technology, you need infrastructure, regulations, safety and return on investments. I have no problem with these technologies- they are local developments, but we should not forget that SA is a technology taker. There however seem to be duplication in terms of R&D- there is no need for this. Catalytic converters as an example, have a well-established global market (the largest export component in terms of value from 2013 to 2017 and at the same time the green component). With the "Joule" you probable the story of that initiative- in SA everything is possible, but it must make business sense. The automobile industry is export oriented. With 50000 units at the time as a requirement for government support, they were too early with the Joule.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**
Taxes vs subsidies- no to more tax. There is too much tax already imposed. Subsidies would be an ideal. All other countries have progressed through the use of demand side interventions. On the regulation side, we need standardisation of things. E.g. BMW and Nissan EV charging infrastructure- is not the same, but through the adoption of international standards, we can have charging infrastructure that can be used by all vehicles irrespective of manufacturer. The growing increase in fuel prices according to NAAMSA, is a very bad decision, especially if it goes along with increases in alternative energy sources, such as electricity. So this provides consumers with no alternatives. For South Africa, you need to first address prioritised realities. In 2008, incentives were provided to promote progress following the recession. We have too much on taxes already- VAT, emission tax, Ad valorem tax. A day after this interview, SA opposition political parties marched to the Department of Finance/National Treasury's offices, expressing concerns over the escalating rise in the price of fuel- this has reached its highest point in SA's history to the level very close to R16/litter. The marchers blame this to the fuel levy, as well as the e-tolls, saying that government is indirectly raising this to finance its failed e-tolling programme.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**
We are far behind from other African countries in terms of cleaner fuels. You see, there is a carrot and stick approach. SA government prefers the stick approach, e.g. emission tax imposed on new vehicle sales. I prefer the carrot approach. SA has signed many binding protocols, including the addition of emission tax on everything. Let us rather say, discourage people not to use a particular kind of initiative while encouraging/incentivising them to use other alternatives. But the challenge is if the existing alternatives get punished. Do not just punish people, while giving them no other choices. The challenge in SA is lack of integration, with one department doing this while the other does the opposite.
On the employment side, there are multiplier effects in the economy. Without the 7 OEMs that we have in the country, the impact in the economy would be huge. I will share with you a document on what would happen if this industry disappears. The country needs policy certainty. We have this up to 2035 (i.e. the Automotive Master Plan). There is however need for policy cohesion at government level.

I conclusion, in SA, we have capacity to do things. However, practical issues cannot be ignored, e.g. cleaner fuels. These are priorities that need to be addressed. There is a need for government to provide long term policy certainty. **The dti** should support the industry to get cleaner fuels, resolve logistic issues. Hence if there is a way, **the dti** should influence processes of government departments such as DoE and DPE on this cleaner fuels issue.

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INTERVIEW 8.

With MHan of the United Nations Industry Development Organisation (UNIDO) on 21 May 2018, at SANEDI Offices, Johannesburg.

The interview respondent started off by providing advice on potential interviewees, the author could approach. Those could include DST's Dr Maserumule and Dr Chiteme, since they have done a number of work pertaining to alternative fuels. Also Dr Mathe of CSIR was suggested, for, he has done a lot of work on batteries. Also, uYilo- Dr Nico and or Mr Parmar and CSIR's Energy Centre- Pieter Mokomo, the City of Cape Town regarding work on tariffs for EV charging, and Gauteng provincial transport department.

A. **Green transportation- what is your understanding or views on this topic?**

Efficiency in the industry- sustainability- move away from using energy from combustion, instead use energy that is clean. Over the years, research conducted point to EVs as the most efficient technology of them all, especially if it uses renewable energy, specifically solar. The whole world is moving towards that direction,

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Definitely, pressure put on different countries to avoid going on the direction of greenhouse gas emissions. A goal has been set on climate change and South Africa should not be left behind. The business as usual route will hence not help.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

Internationally, the IEA set a target of where the country should get EVs on the road. Studies have been done on how the transport sector should do to achieve these targets. Then let us not put our own targets, e.g. DEA set targets on EV roll out in South Africa, but not there yet. Government, consumers and OEMs should do something, all playing some role.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Same as above……

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

SA is not there yet. There is a lot that still needs to be done. The legislative environment is not there yet. E.g. A framework enabling SA to become manufacturers of EVs. SA should not rely on the international community, but to develop our know-how, e.g. the not so difficult technology- batteries. We also need to make such technology accessible. We need to set up attractive incentives to encourage technology adoption. We need to incentivise development of supporting infrastructure. Unless they foresee profits, investors will never invest in such. So create incentives to encourage investors, including international one. So open the market for anyone to invest, instead of allowing about 2 OEMs to dominate the local market. The EU- it looks like they will lose the market to the Chinese. Soon China will exceed EU in EV manufacturing and adoption as EU tend to resist new technologies. SA can capitilise on this.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Links to the previous. SA is currently a player in automotive exports- but has to take a lead- currently it seems to be overtaken by other African countries when it comes to EV manufacturing- these countries are taking a centre stage. SA gets set back by unconducive policy framework.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

A combination of all these instruments would serve South Africa better. We need incentives, i.e. monetary ones as well as non-monetary ones. Examples of non-monetary incentives include

- Lanes for EV users, e.g. Cape Town- bus lanes on the highway.
- Car free zone, e.g. in high pollution areas- restrict passenger cars. Do not allow them at certain times of the day, - this is already happening in other countries.
- Incentivise electricity, e.g. feeding of electricity into the grid.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Links to the previous section, however the macroeconomic study currently underway, will feed more into this one. It should provide an idea of what needs to be done in order not to jeopardise jobs.

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INTERVIEW 9.

With MH of KZN Provincial Department of Economic/transport department on 08 June 2018, in a telephone interview.

This was a teleconference, with me in Johannesburg- Sandton and MH in KZN- Pietermaritzburg. MH works amongst other projects, with the Durban Aerotropolis- building a new city around the King Shaka Airport, Dube Trade port. It is a city, which they plan to incorporate a lot of green elements, including Eco-mobility concepts.

A. **Green transportation- what is your understanding or views on this topic?**

We cannot continue business as usual. We cannot work like that. EVs have to come to South Africa. Watch what the rest of the world is doing. We are in a transition to a greener economy, whether we like it or not. If we do not do anything as a country, the world will eventually dump Internal Combustion Engines to us. We will be dumping grounds for such, and they will be given to us, free of charge (this statement was also heard from an EV lobbyist at the Sustainability Week Conference a day before this interview). Chances, we will also be dumping them further to the rest of Africa (i.e. not being creative as called for by another interview respondent- R. of DEA).

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Off course- As a country, we are a couple of years too late already. Do people believe in policies? We have policies in SA, green economy, National Development Plan, etc. Do people really believe in them? In KZN, there is even a Green Economy Strategy for the province.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

The Non-motorised Transport (NMT) - walking and circling- I do not see that flying in SA. It will depend on what that is for. Regarding freight, the story on semi-electric vs fuel powered, I think we will have all these technologies. It just depends on what one needs it for. As for long distance, one tech may work over the other, and another tech for shorter distances. As for fuel cells, it is very difficult to produce, hence SA should rather watch what the world is doing as opposed to jumping on technologies that are not showing signs of support at global level. In SA, we have abundance of resources, but is that the way to go?

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

We need to breakdown the transportation, fleet, public transportation, etc. Technologies change, moving heavy fleet- not too many on the road, hence government has to be a leader in this space. Government needs to create a demand. Government also needs to develop the supply chain- start to promote local manufacturing of automobiles. If we do not start doing so, where will we sell out automobiles in the years to come, since our export destinations are slowly moving away from ICE type of vehicles? We are going to lose the market as a country and start importing dumped ICEs from the rest of the world.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

We need an overarching plan about how this is going to work. Political system change from time to time. Green transportation as cross-cutting issue, is indeed bound to face challenges that come with this political chopping and changing of political heads. So, these are real life treats to the success of these initiatives. Commitments by one leader, as example, often get ignored by the next leader, hence posing a real uncertainty to the developments moving forward.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

No covered due to network issues

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Subsidies- we really do not need subsidies, but rather to reduce tariffs on products such as imported EVs. The taxation system is rather too high. It is too expensive to buy such green vehicles. *The reduction of import duties looks like a subsidy to me. Unfortunately, the network problem made it hard to continue probing this respondent on the tax vs subsidy regime.*

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Not covered due to network challenges with the respondent.

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INTERVIEW 10.

With MM of National Treasury, Wednesday, 07 March 2018, at her offices in Pretoria. She does work which focuses on Environment and Fuel Taxes-Energy efficiency, motor vehicles, biodiversity, etc.

A. **Green transportation- what is your understanding or views on this topic?**

Green transport- economy/ country move away from fossil fuel dependent transportation. A move to low carbon transport. The main driving policy initiatives being the climate Change Mitigation Response Policy and the National Development Plan (NDP). There are commitments at international level to assist curb the emission of greenhouse gases. The idea is to discourage too much driving, incentivize public transport use. There is hence a need to improve public transport systems and use of renewable energy. There is a need to deal with negative externalities associated with exhaust gas emissions, pollution affecting the poorest of the poor. So this has connotation for a lot of issues faced by South Africans. Regarding the biofuels levy, it is not there yet, but the strategy would have worked if we address other issues including food security, use of non-food crops, etc. There is a need for a subsidy that will target benefit to the poor through community development. The strategy failed because it earmarked some communities and prioritized these over others. Why were other needing communities left out? There is hence a need to look at other alternative fuels. So with good planning that strategy would have worked.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

We have to do it- we drive too much. But without reliable public transport it is hard to achieve green transportation. Take Gautrain as an example, it is not reaching all other areas. We also need to look at spatial planning. People living far away from work areas. To these people, things like walking would not work for them, but rather a reliable public transport system would suit them better.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered**

vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?

We need to diversify. Having a variety is the best option for a country like South Africa. When we do that however, we need to focus on options that we have a comparative advantage on. While the focus should be in reducing emissions, we however need to also focus on reducing the cost, i.e. go for options that attempt to achieve a certain level of balance when it comes to this. If we use subsidies, we need to check who we are aiming to benefit. What other government objectives are we aiming to achieve. Regarding the Non-Motorised Transport (NMT), we need to encourage that, but for now it only works for people who work close to their residential areas. It goes hand in hand with the health promotion levy. Another challenge is that, fossil fuel subsidies lead to the price of these fuels being far below the actual costs of fossil fuel use. They are retrogressive, i.e. benefiting high income families/ users. The basic fuel price- there is too much in it. Regarding deregulation, this is a sensitive issue. It is like if government takes this route, it will shut small players out of the business, leaving the large multinational companies monopolizing the market (link this to Bongani of Radio 702 interview with DDG Maqubela of DOE on the fuel levy)

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward**

Answer is the same as in C above, i.e. we should not pick the technology but rather to diversify focusing on what our comparative advantage is.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Not discussed due to time constraint.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

South Africa is behind compared to other countries in the world, but is not doing very bad comparatively.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Taxes, subsidies or regulations- market based instruments are the best since they provide a certain level of flexibility. These instruments send a good signal. Regarding the regulations, they do not do that- there is not much flexibility and as such they do not encourage innovation beyond what they stipulate. They are however still needed to compliment market based instruments. Electricity price is very low in South Africa. So, you need a pervasive incentive- a targeted funding programme that works. Subsidised public transport as an example, however needs to be subjected to some form of localization requirement (PPPFA). Ring-fencing not supported by Treasury- only the excise duty that was imposed to change behavior gets slightly ring fenced, e.g. the plastic bag levy. But look at the challenges such schemes have experienced over time in South Africa. Will share a research report done by GTAC on transportation. Looking at how much we are subsidized in South Africa. With shrinking funds overtime, we would not be able to fund government spending is we take the ring-fencing route. Example, the Road Accident Fund always go back to the transportation sector. This always run out. Government needs money to spend on a lot of things, but our revenue sources are very limited, i.e. mainly VAT, Income tax, product tax. We do not generate a lot of revenue from government business.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations**

Not discussed in detail, but the answer is the same as in G above.

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INTERVIEW 11.

With MT of the Department of Environmental Affairs, working in a portfolio around sustainable development on 18 May 2018, at the Environment House, Arcadia, Pretoria.

Question if the following institutions will also be approached for their views. Human Settlements, Health, Labour and Education? Also, that Stats SA through its household survey, may have information on the impacts of transport on health. Issues related to occupational health, especially among employees in toll- gates. They seem to be exposed to so much tail pipe emissions from vehicles taking off as they exit toll gates (so, this is an air quality issue) What kind of sampling are you using? If you use purposive sampling, perhaps you can also use a snowballing technique on top of the purposive sample to select your interviewees. And how many people are you targeting by the way? Most people I have seen go for very small samples, others doing as small as 12 people.

A. **Green transportation- what is your understanding or views on this topic?**

Part of being efficient, at both practical and/ or theoretical levels. In terms of vehicle occupancy, this involves having more than one person at the time in a vehicle. This include the use of buses, trains. In terms of fuel types, that includes the use of lesser emitting fuels and in terms of vehicle technology, lesser emitting vehicles. So one needs to look at this from a life circle point of view. There has been a study comparing EVs and ICEs in terms of their long term impacts. E.g., that one is only efficient within the 5000km period, after which it becomes worse than the other. There are indeed different angles of seeing greenness. Vehicle manufactures – use of different raw materials, and hence yielding to different efficiencies. So sources of these raw materials contribute to pollution, e.g. during shipping, etc. There is hence vertical and horizontal integration, so the source of materials used in vehicle manufacturing have an impact on whether the final vehicle is green or not. Check for a case study where EU takes Germany to court. It must then be noted that green is a/ can be a political issue.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

It makes sense- from a natural resource point of view. What matters is the how, when, why and who does it.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

Different pros and cons. Look at each of them focusing on the life circle assessment point. However, a proper life assessment needs to be undertaken- focusing on all input across the value chain, example the work that Eskom did on transformers and PCBs. We have to dig dipper into technologies before we buy into the idea from any rent seeker.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Same as in C above, i.e. get more info before buying into any technology idea.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

That depends on what you want. People lobby for specific policies depending on the specific technologies they want to see.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Quick comparison- e.g. Norway had a good policy that sought to promote EV uptake. But now, there is a rebound effect. Many of these previously subsidised EVs now cause traffic jams in lanes that have exclusive access to eco-friendly vehicles, such as buses. Norway had phases, where some of these eco-friendly vehicles did not have to pay for parking in certain malls, with most costs incurred by government. With these phases now coming to an end, which marks new challenges to the vehicles that were benefiting from such a scheme. When I was in Norway, all I could see was an EV after an EV in the robots. On the issue of the value of fuel related imports far exceeding the value of all exports of Mineral such as gold, platinum, etc., there is at times deliberate devaluation of SA products, i.e. there are vested interests, but yet this is a global value chain issue. Perhaps you also need to check globalisation theories and do comparison analysis. There are many players, e.g. BMW, Nissan- the question is, what are they doing in this space? How far do they want to go green?

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Perhaps, you need to do comparison analysis. Off course the developmental, political and macroeconomic dynamics differ between SA and these countries.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Same as above.

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INTERVIEW 12.

With PM of the Department of transport, on 01 February 2018 at her place in Pretoria

A. **Green transportation- what is your understanding or views on this topic?**

Environmentally friendly, not harmful to the environment. New technologies, less harmful. To also include non-motorised modes of transportation

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Yes it is. Transport sector is the second largest contributor to GHG emissions in South Africa. GHS have direct negative impacts on the environment. RSA's constitution makes provisions for the protection of humans from harm. The NEMA also makes provisions aimed at ensuring a safe and healthy living environment. It makes provisions for sustainable development. It set sustainable development principles. So, green transportation, like sustainable development aims at achieving a certain level of balance. All these things are important. So, in the department of transport's view, development of green transportation transport will be the start of green transportation policy development in South Africa. Required legislative changes are as follows: possibility of localisation of expensive components such as battery packs, import tariff reduction- EVs, provision of incentives that is the dti's role. DoT should bring in the EVs, DoE renewable energy so that the EVs are not charged from the Eskom's coal dirty energy. These need to talk to each other.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

All technologies being introduced- do not pick a technology, but do look for those which are greener, independent and can be implemented with minimum resource requirements. The challenge is the infrastructure… not well developed in South Africa. Where I live there is a bus only in the afternoon at 3 and 5 pm respectively from town. In the morning, one has to go long distances to get a taxi. It is therefore important that the country's citizens should get exposed to technology competition.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

The response here is the same as in c above- meaning, do not pick a technology yet- embrace them all.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Get technology to the market. Let these technologies be seen and think about policies later. Example…City of Johannesburg, City of Cape Town and City of Tshwane went ahead, no problem. But what about accidents, insurance issue and Road Accident Fund. So, get the technologies to prove themselves first, then attend to these issues at a policy level.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

SA is well behind compared to other countries. Climate response strategy we keep referring to this.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

We need a bit of all these tools. Subsidies are required to service especially the poorest members of society. As for regulations, those who can afford, these should target them in order to enhance compliance. As for taxes- adding more burden to the country's citizens is not a good idea. We are already paying more tax as a country. Another reason for not choosing tax is that, tax goes to one basket. It is National Treasury who decides what to do with it. There is no ring-fencing, hence taxing green transportation. The money collected will not go back to green transport related matters.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Response similar to that given in G above.

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INTERVIEW 13.

With R of the Department of Environmental Affairs on 05 February 2018, at her offices in the Environment House, Arcadia, Pretoria

A. **Green transportation- what is your understanding or views on this topic?**

Clear policy- improved efficiencies in transportation. Technologies leading to low carbon. Would like to see developments in spatial planning. Improvements in infrastructure, with renewable energy technologies, paving to improve cycling, modal shift, alternative fuels with low carbon use. Non-motorized transport (NMT).

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Yes, air quality issues in this country. Urban environments and current planning set up forces us to use more transport than we would have preferred. There are health and economic issues. We spend too much on imported petroleum products. Trade deficit issues, balance of payment issues, affordability issues. Renewable energy, energy efficient vehicles is what is needed. A need to develop these vehicles in SA for the regional market, East Africa as an example. SA is well placed. These countries use old vehicles imported from the Asian countries. These can be assembled / manufactured in SA for export to this market. What is required though is leadership here in SA and at regional level to make this happen. At EVIA, the dti is viewed as an important player to provide some guidance on a number of these issues. The dti's role and presence in these forums is considered to be of critical importance. SA to develop manufacturing capability for small engine and efficient vehicles for export to Africa.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas**

Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?

Great, but technology neutrality is needed. But EVs, that is my wish that SA should capitalize on these. CNG/ Biogas as well. CNG/BNG market in Mozambique. So why not manufacture components and vehicles in SA and export them to Mozambique. Biofuels seems dead though, and as for dual fuels… we need infrastructure. Walking and cycling- seem a least costly development, with little needed in terms of resources, so why not go for them. As for hydrogen fuel cells, DST seems to be doing some good job there through HySA. We however still need direction. It is not clear- developments in government are not good. There are biogas pilots in JHB, buy hydrogen, any recent?

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

EV and Hydrogen- market, minerals we have in SA. There are value chains and possibilities to beneficiate the minerals. There is enough expertise in these areas. We can generate stable electric power and through SADC power pool can capitalize on this. Solar energy in particular. To charge the vehicles. Why not develop a SADC Solar energy farms. We however need strong leadership. We can create our own brand and still be able to sell to the African market- we have it right at our door steps.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Yes, that depends on the type of country you are in. Economic power, government strength is very important. Government role is very huge. National Treasury on climate change however grants are not good. The PTNG (subsidy) as an example. Is not designed to cater for green transportation. Grant funding from government is not available. Clarity and consistency is a start. What are the government priorities? DST on fuel cells, but uncertainty. That is very damaging to the government. The NAT MAP- should not differ much from the GTS. The transport strategy of 2009 was stopped- but was the best strategy till today. The fuel economy standard. Final commitment? The transport month relievers a lot of good things on this, however we need transportation discussion that will be translated into implementable actions. Currently, this is not done well.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Public transport Policy – was very good (2006). Although it did not cover all green issues, it was however good in covering broader policy issues. The NATMAP- Not too bad- used a lot of multi-criteria technique. The SIPS- not a bad one. Carbon tax on vehicle emissions- but still nothing coming together. White paper on energy policy

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Public transportation- subsidies are preferred. Taxation is so weak for now. Carbon tax does not cover transport for now. Only focuses on point source and fuel manufactures. As for subsidies, young people aspiring to acquire a car want to own it. Sick and tired of taxis, so trying to stop them from owning cars when they can afford and they have never owned any vehicles. It is not going to work. Besides, people are tired of walking long distances from taxis, hence at times, they need their own transport which take them from point A to point B.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Subsidies, aimed at assisting the poorest users of transportation.

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INTERVIEW 14.

With SX of the Department of Science and Technology at his offices on 20 June 2018.

The interview was scheduled between Mr Xosa, Dr Maserumule and Dr Chiteme. However, only Mr Xosa made it to the interview "due to the emergency funeral service that Dr Maserumule and Dr Chiteme had to attend in the DST campus on the day". The ineterview with Mr Xosa however went well, as follows:

A. **Green transportation- what is your understanding or views on this topic?**

Best way to answer it… focus on specifics. The operative word "green" indicates the nature of this. When you use it, plannet earth should remain without/ with minimul disturbnce on it. But is is difficult, e.g. type of fuel used and propulsion systems. When you move from point one to the next, what is your environmental foofprint. Othere talk about the socio-economic aspects, but that is not the only one. Maybe the best way to deal with it would be, let us make a call to leave for today and forget about the future. Is that right or we should rethink future generations vs current generations. E.g. mining, mining industry and the impact this has had on e.g. acid rain, seismic events. Yes, we built cities like JHB, but what after all the reosurces are depleted?. So the issue basically is sustainability. So one can use the sane anology for the tranport sector.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Agreement that this is addressed above in A

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

I must comment- SA governemnt has moved to this front. The worry however is the rate at which it has moved. The intent is there, technical capability is there, but it is not full. There is potential for market, but we lack the "make it happen". This lies solely with politicians. E.g. Gautrain, road to rail and the kind of resistance encoutered, Gauteng pushed, and political will was there. This was even called " Shilowa Train" due to the provincial premier at the time being Mbazima Shilowa. It is indeed a usefull service now, with about 45-50% people, who by the way, own vehicles, now utilising this service. Despite the reluctance of national government, the provincial government pushed for this to happen. Also, the idea of a "tram" running from Soweto and JHB, was a good one. That would have catered for a large volume of daily commuteers. So the major challenge is indecision and delays on the part of governemnt decision makers.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

My recommendation woud be, we need to do a cost-benefit analysis, allowing the market to guide the process- what is likely to be there. We should not be prescriptive. We shoukd allow the market to go for a competitive technoogy, not only in terms of price, but also in terms of many other factors. Infact, in rural areas, the situation is so bad that, there is no movement of things. A lot can be done, including demonstration of green tehcnologies. E.g. dusposal of governemnt fleet, such as those you see when driving along R21 to OR Tambo airport. There are trucks from the military. These can be converted to green tech such as CNG, Biofuels, taken and used in difficult rural terains. In the process, that country will be learning while at the same time addressing the real transportation problem that these remote areas are faced with. So after going to clearance, why not take these vehicles (as most of them should still be in a driveable condition), explore with NDT on the conversion of these machines. We should not just say, CNG, Biodieses, EVs, but let us rather look at the indigenous solutions.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

In my view, even though not all policies are specific to transport greening, they are broad. Only now that we have the green transport strategy, that we are beginning to get there. At times, we have made blinders at policy level. What is there has components to support the transition. What is there needs to be deliberate. Lack of coordination is still there, e.g. biofuels… since 2005 (engagement at government level). Still 10 years later, still no biofuel plant. Policy is there, not strong enough, but it can be improved.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Very difficult, some would be case by case while others would be in terms of the colleective, e.g. biofuels incentives. The key is availability of clear policy directive based on techno assessment. As a country, we are still far behind. We hence need to be very clear in terms of what we want to do. We need a clear strategy that will change the prospect of this coutry. If we say we want to reduce the emmisions, the pupulation may not approve, but if we want to talk about socio-economic issies, this might get approval. Poor vs the affordability.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

There must be some kind of net benefit to governemnt. A determination needs to be made on e.g., support under what circumstances. What will be the benefit government to stimulate investments. Howver governemnt's involvement should be minute fraction. E.g. if we spend 20%, we should get 80% in return/ achievement.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Not discussed, but rather addressed in the previous sections.

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INTERVIEW 15.

With SM of the Department of Trade and Industry, at the dti Campus on 25 May 2018

A. **Green transportation- what is your understanding or views on this topic?**

This would involve taking transport away from internal combustion engine (ICE) - away from petrol and diesel. This should include new inventions such as EVs, CNG, fuel cells. With these technologies, the jury is there. The idea is to adopt technologies that will reduce the country's carbon footprint. I come from the school of theory- that focuses on the heavy commercial side of things, which promotes change of transportation mode from road to rail. Off course, there is a challenge, i.e. the monopolistic nature of the industry.

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

There are many issues in SA which include, driver behavior, car routes, traffic, etc. there are various levels of intervention- we could better support the industry through the use of rail- long history in South Africa. Trucks and buses- these are mainly imported, but there is potential for localization in this space. We have certain capabilities, but however these are a bit stunted, mainly due to too much state intervention. On the R&D, we could achieve more if there was pure privatization, e.g. Transnet and subsidiary components. There has been a lot of laziness. There is insufficient competition, hence the growth of freight. There is a lot of competing priorities within government. As such- greening and sustainability are key to this whole thing. I hence congratulate you for researching this area. It is important for the country to have a legislative environment that is able to support its vision. That will help the country coordinate and achieve its objectives.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

Own personnel feelings- for SA, it is early days. Majority of technologies are not fully fledged. With CNG still on the test stages. Besides, all these green technologies are being imported. Development work is undertaken elsewhere, i.e. solution is developed under a different set of circumstances prevailing under those countries. So, make a choice now based on what? Let us rather get the data/ information, then build from the backdrop of such information. Without such evidence, it will be difficult to pick a technology. Let us be deliberate, but knowing that eventually, we will have to take a view/ position at a certain period/ time, because we cannot be perpetual with the status quo. So, do your own matrix first, filter the technology out of this matrix. We need to have the fleet, experience and the know-how.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Most discussion above covers this question.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

This points to the issue of competition. We have competing priorities as a country. Primary drivers right now are the socio-economic conditions that the state operates under in the country. Jobs, the economy, should be the primary goals. Not enough work has been done to present the benefits of greening to supporting/ benefiting the primary goals. Why green. More clear cases for this should be presented to the policy maker in order to aid decision making. Over the years, the status quo (fossil fuel use in the ICE of vehicles) has proved itself very well in terms of its ability to achieve the socio-economic aspect of the transport sector. So any change should be justifiable, not only in environmental sense, but also in its ability to improve the status quo from a socio-economic development point of view. It looks like at the present moment, industrial policy protects/ favors the status quo industry precisely for reasons stated above. Futuristic industries are hence deemed to be secondary. So, the advice is, do it within the context of regional economy. SA needs to pull the region together with it, because the region provides a bigger market for this country. There must be some kind of a scientific exercise, examining the costs and benefits of the status quo vs the futuristic technologies. There are external legislative frameworks that have a bearing on what South Africa does, which in turn have linkages with global value chains, e.g. the EU standards. These have implications for the industry that cleans fuels. South Africa needs to create some kind of a roadmap, which indicates the country's gradual move to cleaner technologies. Rather than an overnight switch from one technology to the next, starting from engine efficiency to fuel economy, etc. If you do not do this, there tends to be a displacement effect.

On a different issue of under 1000CCs, EU took advantage- studied the market and pushed to 0% duty on the imports. These are not a big thing in SA, but can tap into this market, e.g. by providing demand side incentives to e.g. first time buyers. For the ones made in the RSA, provide VAT free dispensation to encourage purchase of local ones, e.g. 15% tax break. Examples include Polo under 1000CCs.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Most information here is covered in E above.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

Countries like the US, Spain and Italy- state fleet/ public fleet procurement is tested in these green technologies. This worked well in these countries. Significant investments and infrastructure built is done at state levels (about 14 billion?). Quantum of spend (RT57) is done at this level. Government runs the fleet for about 5-10 years, through an international operator. Perhaps SA can try this model where state procurement is involved, however excluding vehicle purchase by private individuals (revisit this- DoT proposed in the GTS, some kind of green procurement guidelines for SA).

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

Not covered

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INTERVIEW 16

With TK of the Department of Trade and Industry, on 25 May 2018

From 2005, joined DMR, then back to **the dti** 10 years later after realising that there are still gaps in industrial policy pertaining to primary mineral beneficiation. I need to make an upfront declaration that, in South Africa we need to sell platinum. SA has 52 minerals. The McKenzie study anticipated cell phone subscription of 900000 units, whereas the actual number indeed was 109 million.

A. **Green transportation- what is your understanding or views on this topic?**

From my thinking, emissions and environmental pollution. These contribute to global warming. So we have to deal with that. We need to opt for alternatives in the transportation and coal fired stations. My understanding is that from different types of transport modes, what are the alternatives in there?

B. **From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?**

Of course, back to the argument that yes, global warming is an issue, but for me personally, I am more lenient towards the health issues. I like what Chinese have gone about it, greening the transport sector to address their health bill associated with lung cancer/ diseases, etc. Historical costs to the country in terms of medical bills has been huge. Air quality and lung cancer cases, drove their greening initiatives. In the case of South Africa, even though this is unrelated to transport greening, but also the issue of Silicosis case- mine workers- the biggest court case in SA mine workers have done.

C. **Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?**

My views are limited to fuel cells (not even hydrogen because there are different types of fuel cells). We have engaged with countries that have done a lot of work in this area. The city of Stuttgart Transport Department- Germany. They have tested all greening technologies, but one technology that stood out prominently in terms of efficiencies that they deem suitable for their region is going to be fuel cells. For South Africa, it is definitely not going to be one technology, but rather a mix of them. But that will depend on the requirements of a particular region. In the short run, do not choose/ pick a technology, but in the long-run, efficiency will be the leading driver. Most efficient technology will dominate the space. In my unit, I am paid to sell platinum. SA is obviously a mining country. Platinum Group Metals (PGM), about 80% of the world reserves is found in Rustenburg. We share with Russia and Zimbabwe. Difference between crude oil and PGM is that, PGM is recyclable- and will always be there in the system and does not lose its characteristics. Crude oil depletes. Its combustion contributes to global warming and pollution issues. About 44% of platinum goes to catalytic converts, 32% to jewellery and the rest to industrial applications. Unlike gold, platinum is the most stubborn material, you cannot just refine it- so no zama zama's. 4 players in South Africa… Impala (Implats), Anglo American, Lonmin (facing many challenges right now) and Sibanye. This last one operates "still water", i.e. a platinum recycling operation or urban mining. Collects platinum from various areas and refines it. It seems to be growing at fast rate, and is likely to surpass the operations that mine version material. Cat converters use either Platinum, Palladium and…. Palladium however is the most used one. Bringing in EVs, that means that, about 44% platinum will be forgone. PGM is SA's 2nd biggest exporter by value, after automotives. Mining alone employs about 500000 people (of these, 200000 in the PGM). Germans say that fuel cells (hydrogen, water, electrolysis, solar or wind) generates truly zero emissions. So, these arguments have always provided justification for promoting fuel cells.

D. **If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?**

Answered above, but to add more… a combination of the technologies would do. In the long term though, only the most efficient technology. We still need foreign markets. China as an example, have the biggest market indirectly (for vehicles-cat converters). Japan is the largest world market for platinum. They have developed the first fuel cell powered vehicle. EVs are not bad because we can still sell minerals, e.g. lithium, etc.

E. **Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?**

Similar to the response provided above… The EU Standards- about 44% demand on platinum was brought about by these standards. We would not have auto cat converters if it was not for the EU standards. SA is a very small global player, with a very small market. Let us rather influence policy at global level. Own policies can be fine to have, but let us influence the global view/ space. Let us look at numbers, transport is a numbers game, e.g. smart cities are about how many people in number. Why don't we develop fuel cell buses- designation- investors want a guarantee? Cell phone masts, as an example. A shift away from using diesel is not just a cost issue, but also a theft issue. So let us adopt a mixed approach.

As for new policies, not really necessary, why create more bureaucracies from development of new legislation. African market, not the best to target. Not a lot of money there, so if we target this market, what are we going to make? In SA, we do not have sufficient market- that determines what goes into a product. Why don't we develop indigenous products? Let us talk about the taxi industry- some kind of a fuel cell taxi? This is a unique industry, not available anywhere in the world. India, maybe? China as well, but mainly in the delivery sector? As a numbers game, transport—many people in SA use minibus taxis- not buses. There is indeed an infrastructure issue.

F. **If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?**

Same as above… the challenge with SA is that we are supplying what is not in demand. Yes, this is a policy issue. BRT- Areyeng vs Reya Vaya. Buses for the former always run empty because they targeted wrong routes. As for the later, buses for Soweto are always full. So that is the correct market. Talk about Busmark- the City of Cape Town example- they procured ByD buses, with local Busmark providing chassis for such (local content exemption given?). But very heavy battery packs from China, the bus had to be lifted on the truck from JHB to Cape Town. 11 EVs, with one already completed as a pilot. Now, a fuel range extender pilot is being developed in partnership between Stuttgart Bus Company and the city of Cape Town to reduce the weight of these buses. This pilot with metros, including awareness raising, study tour to Stuttgart which included mining companies as well. From that Impala committed to converting all of 50 buses from diesel to hydrogen fuel cells in Rustenburg. This will send a strong message about SA's commitment to this technology. Anglo American committed to putting money on the metro buses. Through the C40 Bus declaration- signed between 2 metros- Tshwane and Johannesburg. Contact persons at the City of Cape Town- James Groep or Johan (the person that **the dti** worked with in the fuel cell project). A suggestion that I should also talk to Busmark. One thing I learned from china is that, Government created red tape for itself in order to exist. So the same can be said about South Africa, why industrial policy in the first place. So in South Africa, there is no coordination- everyone seems to be doing different things. There is a policy certainty issue, which hinders investments in this industry. Is RSA really into this? What if it pulls out when so much investments have already been made? The municipal pilot project- DBSA and GCF are willing to fund- but metros are seen as both project sponsors and implementers. An SPV between 3 metros- COJ, COT and Ekurhuleni. Concept document in paper already, will share it. It is designed to run in 2 phases, with 4-10 pilot vehicles first. Challenge with this SPV is political changes that happened. The 2 metros are run by the DA while one is done by the ANC. There is heightened willingness on the part of the ANC one, but a bit of reluctance on the part of the decision makers, given the fact that they do not want to be seen to be supporting the ANC led metro.

G. **Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?**

This was not covered in the hope that is it mostly covered in the discussion above.

H. **If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?**

This was not discussed in the hope that it is also covered in the discussion above.

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INTERVIEW 17.

With TS of the South African National Energy Development Institute (SANEDI) at CEF offices, Sandton

08 June 2018

A. Green transportation- what is your understanding or views on this topic?

Using our green energy sources for the transport sector, moving away from conventional dirty fuels. Only if we use renewable sources, e.g. solar, wind and their green forms of energy. EVs, as an example- not zero emission- that depends on the source of energy one uses.

B. From your own perspective, is transport greening a justifiable thing to do/ what should be the rationale for doing it?

Here there could be a country or international perspective. But let us look at South Africa. Fuel sector- we import crude oil. From an economic perspective, the question is how could we reduce the import of this crude oil? From a health and environmental perspective, a country, we committed to reducing the emissions as we are one of the biggest emitters. There is also an industry development view point. We need to have our own intellectual property. We need to develop our own competency as a country in this sector.

C. Various green transportation technologies/initiatives are being introduced / promoted in South Africa, ranging from the development of fuel specifications to the promotion of alternative transportation modes, fuels and vehicles such as Electric Vehicles, Compressed Natural Gas Powered vehicles, Liquefied Petroleum Gas Powered vehicles, Hydrogen Fuel Cell powered vehicles, Biofuel powered vehicles, dual fuel powered vehicles and non-motorized transportation such as walking and cycling: what are your views on these developments?

For me, if you look at development, various players are doing various things, but development is not moving at the pace it should be moving at. Observation- the petroleum sector has a vested interest to keep the status quo. They are very strong- policy wise. They seem to have coordinated themselves very well (so, link this viewpoint to **the dti** 2016 study which found that, the current legislative framework is centred around the conventional ICE-based transportation system, with less provisions targeting the green/ alternative transportation systems). Others are not at the level where one would want to see them. E.g. CNG minibus convention- this worked, but did not achieve acceptance from government. No coordinated efforts. There are pockets of activities, here and there. So, with this, where is this sector going? Also, the Joule car. It profited oversees entrepreneurs, but in South Africa, not much support was given to this project. EVs as an example, you can see movement (especially to those people that can afford them). The EV industry is organising itself very well. What is key is not just what government is doing, e.g. development of the RE industry. Until we see the associations forming, organising the industry, standing up and lobbying government, nothing much is likely to happen. Example, it was not a coincidence that the Wind Industry in South Africa, got so much share it got over other RE technologies. It was all due to this rigorous lobbying from the wind industry association of South Africa (SAWEA). EVIA is doing something along those lines. They try to speak in one voice for the EV industry in SA. Policy workers do not operate like that. No coordination, in fact they operate like they are in competition with one another (they seem to lobby each other to get buy in on one's programmes- not working together toward one common goal). So, link this to systems thinking and the country's supreme law- the constitution. Sanedi looks at all technologies, is not biased towards one technology, not promoting one over others. So, the idea is to provide an objective analysis and views on what is best for the country.

D. If you were to render advice to the South Africans in terms of the best technology for the country, what would be your recommendations moving forward?

Addressed above, however in addition, whatever technology is chosen, it should be based on objective views. Look at all technologies instead of jumping to one technology.

E. Existence of enabling policy / legislative regime has often been cited as one of the most important aspects if a country is to succeed in transitioning to a greener transportation regime, what are your views on this argument?

There has been good developments in policy development in the past years in South Africa. So, we need to look at the development circle and the number of years South Africa has been involved in this green transportation business. I do not want to say that there are not enabling policies, rather to say that there is room from improvement on existing policies. SA is on the right path, but not all necessary requirements to encourage full blown greening industry. I would therefore like to see better coordination between various developments, e.g. The Department of Energy to play a visible role in the EV industry. They don't seem to be playing much role at the present moment in supporting EV roll-out. Yes, there is not enough EVs on the market at the present moment. But when a full blown EV industry takes off in SA, the role of this department will need to be very clear. The EVs require electricity to charge, and if the infrastructure is not there yet, how will the process be managed moving forward?

F. If you were to benchmark South Africa against countries where transition to greener transportation has reached advanced levels, how would you rate South Africa in terms of the existence and efficacy of green transportation policies?

Very difficult to compare SA with developing/ emerging countries because not much is happening in those countries in terms of green transport development. Rather, compare SA with developed countries. But also, if you do so, SA will be underrated since these countries have done a lot of work in this area already. They started many year ago. (This however reminded me of the interview I had with a colleague at work, where he asked me if my study will use comparative models, and where he suggested that I compare SA and BRICS member countries. My colleague's suggestion seemed to make a lot of sense since China and Brazil had already been earmarked as one of the countries to benchmark RSA against. When the respondent provided a view that it would be wrong to compare SA and developed worlds, it raised a conflicting question in my brain if it was still okay to go ahead comparing SA and BRICS member states, given the fact that green transportation in some of these countries, especially Brazil and China, has been happening for many, many years already. So, to a certain extent they might as well be regarded as developed countries). If you compare SA with those countries, it would be wrong to do so. E.g. on the minibus taxis, if you allow RE, what would happen to the grid. Currently Eskom has experience in managing centralised grid, now if you have hundreds and thousands of smaller and decentralised IPPs scattered all over the place, how are you going to manage that?

G. Literature often cites 3 types of policy instruments available in the market: subsidies, regulations and taxation. From your perspective, which instrument would you say is required in a country like South Africa, and why?

Subsidies allow quick adoption of these technologies, so yes that is the tool of choice in, which allows sudden take off of green transportation initiatives in other countries. There is however still an issue of sustainability of subsidised projects- here talk about the interventionist approach- linking the term (how long will it be applied in a system) of a tool and related sustainability implications of such as tool. The theory talks about 3 elements that are required in order for an intervention to become a success. The third requirement of a successful intervention brings in the concept of sustainability. In other words, once the interventionist has left, the system should not die, but continue sustaining itself for as long as its existence is still relevant and justifiable. Taxation as well, is similar to subsidies, depending on how you apply them. Tax can give rise to more profits. All you need to do as a policy maker, is design them correctly to avoid potential long term unintended consequences. They must be fit for purpose.

H. If you were to recommend any of these instruments to the South African policy makers, what would be your recommendations?

Addressed above in G above.

APPENDIX D:
COPY OF CONSENT FORM

CONSENT FORM

UNISA university of south africa

TITLE OF RESEARCH PROJECT

TOWARDS A GREENER ECONOMY: A CRITICAL REVIEW OF SOUTH AFRICA'S POLICY AND LEGISLATIVE RESPONSES TO TRANSPORT GREENING

Dear Mr/Mrs/Miss/Ms __Ms G.K_____________________________ Date: 06 /02/2018.

NATURE AND PURPOSE OF THE STUDY

The world economies have benefitted significantly from the discovery, extraction, refining and utilisation of fossil derived fuels in energy, transport and many other sectors. The use of such fuels on the other hand has continued to attract criticisms for their contribution to climate change, health, security of supply problem and many other factors. Some resource less endowed countries get locked into a dependency syndrome, with their currency being eroded as they continue importing the fuel. As such, the world is slowly moving towards cleaner economic models, including the introduction of alternative and cleaner transportation systems. Energy efficient vehicles, vehicles powered with engines that utilize hybrid fuels, electric, biofuel and compressed bio and natural gases are slowly gaining their way into the world economies. The introduction of these new technologies is often praised for their positive contribution in improving health, climate change, employment creation, security of supply and economic development. While many players are required to facilitate the introduction of such technologies, government is often cited as one of the most important players required to ensure the existence of an investor and consumer friendly and a generally enabling policy, regulatory and incentive regime.

Given the multidisciplinary nature of greening initiatives, this study aims at investigating South Africa's response to the green transition, with the transport sector used as a case study. Within the context of sustainability and systems thinking, the research will evaluate South Africa's legislative regime, and based on international experiences, highlight the gaps and recommend areas for South Africa's policy progression to a better sustainable and greener transportation system.

RESEARCH PROCESS

The study requires your participation in the following manner:

- 23 voluntary participants aged 18 or above from any ethnic, gender and racial group serving in any of the government departments responsible for economic, environment, transport, energy, science and technology, agriculture, forestry, land, finance.
- Participants aged 18 or above from thee industry sub-groups- electric vehicles, biofuels, biogas, compressed natural and biogas will be welcomed.
- Basic demographic information such as a name, surname, organisation, occupation, email and landline number will be requested from participant.
- This research is planned to last for a period of not less than 2 years from January 2017
- Prior to the commencement of interviews with the participants, each will be required to consent, either in written format or orally.
- Oral consent will be recorded on the tape or cell phone for further transcription during data analysis stage.

NOTIFICATION THAT PHOTOGRAPHIC MATERIAL, TAPE RECORDINGS, ETC WILL BE REQUIRED

The researcher's note taking will be supplemented with the use of a recording devise.

Agree	X	Do not agree	

CONFIDENTIALITY

The information you provide is viewed as strictly confidential. Only the researcher will have access to this information. Any person who requires access to such information will have to obtain a separate consent from you. No data published in the final dissertation and journals will contain any information by means of which you may be identified. Your anonymity is therefore ensured.

WITHDRAWAL CLAUSE

You may withdraw from the study at any time, therefore your participation is voluntary until such time as you request otherwise.

POTENTIAL BENEFITS OF THE STUDY

The study will provide an insight into the South African government's legislative and policy approach to transport greening, highlighting the gaps and recommending best possible approaches. The information can be used to inform future direction of policies aimed at greening the transport sector, with the intention of realising the attainment of both the socio-economic and environmental pillars of sustainable development. It can also be used to provide useful background information for future research in this area, hence contributing to the green transport body of knowledge.

INFORMATION (contact information of your supervisor)

If you have any questions concerning the study, you may contact Dr Muchaiteyi Togo at 011-4713934

VETTING OF DISSERTATION

A copy of this dissertation will be made available for your input prior to finalisation for approvals

Share the copy	X	Do not share the copy	

CONSENT

I, the undersigned, ...G.K, Deputy Director, Department of Trade and Industry............, have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signature of participant: Ms. GK...

Signed at ....Pretoria........................ on ...06/02/2018.................................

WITNESSES

1 ......None...

2 ....None...

APPENDIX E:
LIST OF EVENTS ATTENDED AS PARTICIPANT OBSERVER

- Electric Vehicle Industry Alliance (EVIA) meetings/ sessions,
- Researcher observation at the Sustainability Week Conference in 2018,
- Researcher observation at the 2018 RoundTable on Future Mobility,
- Researcher observation at the UNIDO low carbon project steering committee meeting,
- Researcher observation at the Biogas Conference and biogas Platform, 2016,
- Researcher observation at the International Council on Clean Transportation Vehicle Efficiency Research seminars, 2017.
- Researcher observation at the Competition Commission Market Enquiry into Land Based Public Passenger Transport Sector, Durban 2018.
- Presentation made by the City of Cape Town at the Competition Commission's Market Enquiry into Land Based Public Passenger Transport Sector, 21 June 2018.
- Presentation made by the City of Johannesburg at the Competition Commission's Market Enquiry into Land Based Public Passenger Transport Sector, 06 June 2018.
- Researcher observation at various sessions towards the development of National Green Transport Strategy.
- Researcher observation at sseveral sessions within the researcher's own institutions (Department of Trade and Industry), relating to green transport sector development.
- Other purpose designed meetings by private developers and government officials including the one on one meetings with the departments of Energy, Transport and Environmental Affairs.

APPENDIX F:
PERMISSION TO CONDUCT RESEARCH WITHIN A SELECT NUMBER OF INSTITUTIONS

the dti

Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

Private Bag X84, PRETORIA, 0001, **the dti** Campus, 77 Meintjies Street, Sunnyside, 0002, Tel: (012) 394 0000
the dti Customer Contact Centre local: 0861 843 384 International: +27 12 394 9500, www.thedti.gov.za

Enquiries: Leighanne Naicker
Telephone: (012) 394 3577
E-mail LNaicker@thedti.gov.za

Mr Phillip Ninela
Department of Trade and Industry
Pretoria
0002

Dear Mr Ninela

RE: REQUEST FOR APPROVAL TO CONDUCT RESEARCH AT the dti

Your submission requesting approval to conduct research at the Department of Trade and Industry (**the dti**) refers.

the dti is in support of your research towards providing an academic level analysis of South Africa's policy responses to green transport initiatives and is willing to provide you with the necessary support to make the project a success. We trust that the recommendation you will provide will contribute to a better understanding of how Government can play a key role in enabling green transport policies.

Kindly note that approval has been granted on the following conditions:

a) That you complete a Confidentiality Declaration form to ensure compliance with Departmental policies;
b) That you participate in a briefing discussion with the Vetting Unit before commencement of the research;
c) That you provide **the dti** with a detailed research plan and draft questionnaires, surveys and/or interview questionnaires (where applicable); and
d) That you submit a copy of your research report once you have published the final document.

Should you have any further enquiries regarding the content herein, please contact the Director: Human Resource Development, Ms Angie Ontong on 012 394 5980 or email AOntong@thedti.gov.za.

Yours sincerely,

LIONEL OCTOBER
DIRECTOR-GENERAL
DATE: 23 / 09 / 2016

Lefapha la Dikgwebisano le Diintaseteri • Lefapha la Kgwebo le Indasteri • uMnyango wezoHwebo neZimboni • Muhasho wa zwa Mbambadzo na Indasiteri • Department van Handel en Nywerheid • Kgoro ya Kgwebo le Indasteri • Ndzawulo ya le Mabindzu na Tiindastri • LiTiko leTekuhweba netiMboni • ISebe lezoRhwebo noShishino • UmNyango wezokuRhwebelana namaBubulo

Batho Pele - putting people first

national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

Enquiries: Alfred Tau
Telephone: (012) 315-5455
Email: alfred.tau@treasury.gov.za

Mr Phillip Gcina Ninela
Department of Trade and Industry
Private Bag X84
Pretoria
0001

Dear Phillip

RE: PERMISSION TO CONDUCT A RESEARCH WITHIN NATIONAL TREASURY

The National Treasury acknowledges your letter dated 06 September 2016. We are pleased to confirm that your request to conduct a research at the National Treasury has been granted, and Ms Memory Machingambi has been recommended as the official you will be conducting the research with.

While undertaking research at the National Treasury, the following terms and conditions apply:

- You are expected to follow reasonable instructions in relation to the terms of the right of access;
- You are required to co-operate with the National Treasury in discharging its duties under the Health and Safety Act and other health and safety legislation and to take reasonable care for the health and safety of yourself and others while on the National Treasury premises;
- You must observe the same standards of care and propriety in dealing with staff, visitors, equipments and you must act appropriately, responsibly and professionally at all times;

- Ensure all information you have gathered remains secure and *strictly confidential* at all times;
- Ensure that you understand and comply with the requirements of the National Treasury Code of Practice and the Data Protection Act; and
- Furthermore, you should be aware that under the Act, unauthorised disclosure of information is an offence and such disclosures may lead to prosecution.

The department may terminate your right to conduct a research with us at any time either by giving a written notice to you or immediately without any notice if you are in breach of any of the terms and conditions described in this letter, or if you commit any act that we reasonably consider to amount to serious misconduct, or to be disruptive and/or prejudicial to the interests and/or business of the National Treasury.

Please contact Ms Memory Machingambi for further arrangements. Her contact details are: 012 315-5370 or memory.machingambi@treasury.gov.za.

Yours sincerely,

LUNGISA FUZILE

DIRECTOR GENERAL

DATE: 25/11/2016

>>> Phillip Ninela 10/14/2016 3:25 PM >>>
Thank you Bopang

I will gladly incorporate DoT in my data collection methodology. On the completion of the study, which according to my schedule is end of 2018, results will be shared with DoT. I will definitely be in contact with Mr Ssekabira-Ntege should further clarity be required

Regards
Phillip

>>> "Bopang Khutsoane" <KhutsoaB@dot.gov.za> 10/14/2016 2:08 PM >>>
Dear Philip

I have spoken to Mr Ssekabira- Ntege the Director for Research at the DOT, (also copied on this email), regarding your research request, and he has advised that the current way that requests for conducting research are handled, is that the research is first conducted and then the Department will provide a letter confirming the details.

I think that you can also contact Mr. Ssekabira-Ntege directly if you need more information.

I wish you the best in this endeavor, and I cannot wait to read your findings.

Warmest Regards

Bopang Khutsoane (Ms)

Department of Transport
Branch: Integrated Transport Planning
Environmental Coordination: Global Climate Change
Tel: 012 309 3547
Cell: 079 470 9435
E-mail:KhutsoaB@dot.gov.za

From: Deborah Ramalope <DRamalope@environment.gov.za>
To: Phillip Ninela <PNinela@thedti.gov.za>
CC: Mactavish Makwarela <MAMakwarela@environment.gov.za>, Mashudu Mundalamo <MMundalamo@environment.gov.za>
Date: 28/05/2018 07:24
Subject: RE: Green Transport Policy Research- Request for a meeting

Dear Phillip

I suggest you meet with Mr Mactavish Makwarela (copied above) for the interview. He will be able to assist.

All the best.

Regards
Deborah

From: Phillip Ninela [PNinela@thedti.gov.za]
Sent: Friday, 25 May 2018 14:44
To: Deborah Ramalope
Cc: Mactavish Makwarela; Mashudu Mundalamo
Subject: Green Transport Policy Research- Request for a meeting

Dear Ms Ramalope

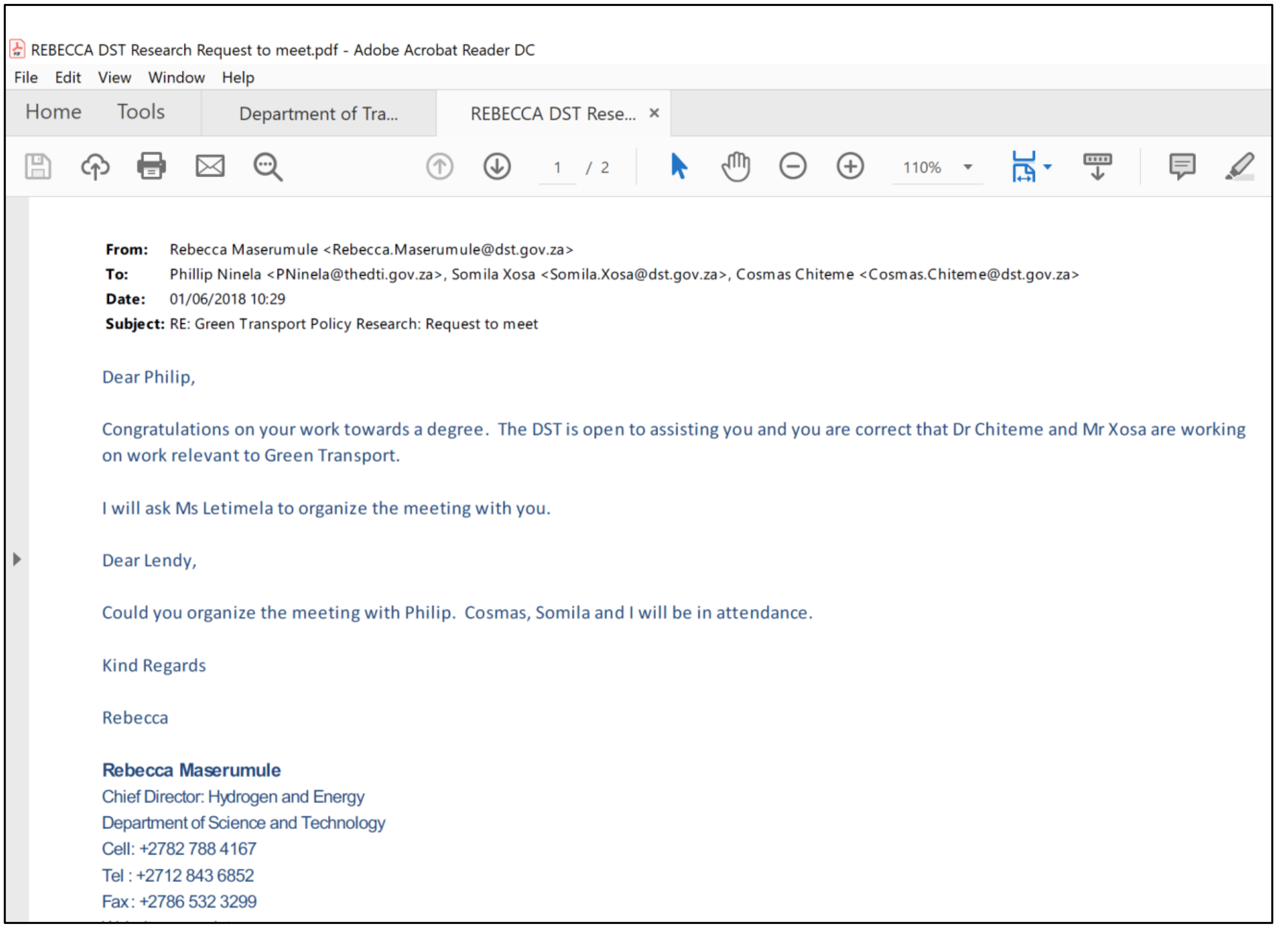
I am a full time serving official at the National Department of Trade and Industry, but currently on sabbatical leave to complete PhD Policy Research in a green economy related field, using the transport sector as a case study. This serves to request an interview with you or a representative from your unit. Kindly find attached a document with more details on the research, as well as the kind of interview guide open-ended questions which will form part of the discussion.

For your information, I have in the past year- 2016 or 2017, approached DEA from the office of the DG, Ms Ngcaba with a similar request. For some reasons however, I could not get feedback following several follow-ups with the office of the DG. I then thought, let me pause a little bit and adjust my approach since DEA is one of the most important players in transport sector greening in this country.

Hope to hear from you

Regards

Phillip Gcina Ninela
Green Industries (Renewable Energy Unit)
Industrial Development Division
Department of Trade and Industry



From: Rebecca Maserumule <Rebecca.Maserumule@dst.gov.za>
To: Phillip Ninela <PNinela@thedti.gov.za>, Somila Xosa <Somila.Xosa@dst.gov.za>, Cosmas Chiteme <Cosmas.Chiteme@dst.gov.za>
Date: 01/06/2018 10:29
Subject: RE: Green Transport Policy Research: Request to meet

Dear Philip,

Congratulations on your work towards a degree. The DST is open to assisting you and you are correct that Dr Chiteme and Mr Xosa are working on work relevant to Green Transport.

I will ask Ms Letimela to organize the meeting with you.

Dear Lendy,

Could you organize the meeting with Philip. Cosmas, Somila and I will be in attendance.

Kind Regards

Rebecca

Rebecca Maserumule
Chief Director: Hydrogen and Energy
Department of Science and Technology
Cell: +2782 788 4167
Tel : +2712 843 6852
Fax: +2786 532 3299

APPENDIX G:
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TOWARDS AGREENER ECONOMY: A CRITICAL REVIEW OF SOUTH AFRICA'S POLICY AND LEGISLATIVE RESPONSES TO TRANSPORT GREENING

by

Phillip Gcinumthetho Ninela

Submitted in accordance with the requirements

for the degree

DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL MANAGEMENT

in the

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF ENVIRONMENTAL SCIENCES

at the

UNIVERSITY OF SOUTH AFRICA

FLORIDA CAMPUS

SUPERVISOR

DR M. TOGO

August 2019

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APPENDIX H:
PROOF OF ARTICLE SUBMISSION TO A JOURNAL

From: "Transport Reviews: A Transnational Transdisciplinary Journal" <onbehalfof@manuscriptcentral.com>
To: <PNinela@thedti.gov.za>, <PGNinela@gmail.com>
Date: 9/7/2019 4:19 PM
Subject: Transport Reviews - Manuscript ID TTRV-2019-0200

07-Sep-2019

Dear Mr Ninela:

Your manuscript entitled "Evaluation of policy responses to the greening of land-based transport industry: The case of the Republic of South Africa" has been successfully submitted online and is presently being given full consideration for publication in Transport Reviews.

Your manuscript ID is TTRV-2019-0200.

Please mention the above manuscript ID in all future correspondence or when calling the office for questions. If there are any changes in your street address or e-mail address, please log in to Manuscript Central at https://mc.manuscriptcentral.com/ttrv and edit your user information as appropriate.

You can also view the status of your manuscript at any time by checking your Author Centre after logging in to https://mc.manuscriptcentral.com/ttrv.

Thank you for submitting your manuscript to Transport Reviews.

Sincerely,
Transport Reviews Editorial Office
<i>Tweet us @TransptReviews</i>

Evaluation of policy responses to the greening of land-based transport industry: The case of the Republic of South Africa

Journal:	*Transport Reviews: A Transnational Transdisciplinary Journal*
Manuscript ID	Draft
Manuscript Type:	Original Article
Keywords:	fossil fuels, pollution problem, policy routes, support incentives, transport greening, globalisation

Evaluation of policy responses to the greening of land-based transport industry: The case of the Republic of South Africa

Located in the Southern tip of the Africa continent, South Africa is a young democracy dating back to the early 1990s. To fulfil its constitutional responsibilities, government is expected to provide numerous services including land transportation which among others, is accessible and affordable to the country's citizens. This service however competes with other key issues of national importance. The transport sector is one of the country's major consumers of energy and emitters of gases that negatively affect air quality and climate. Over 90% of greenhouse gases in this sector, emanate from road vehicles powered by internal combustion engines, mostly fuelled from fossil-derived energy imports. Delays on investments in cleaner fuels by the country's aging fuel refineries, coupled with slow progress on the adoption of alternative technologies means that, the inefficiently old vehicles remain on the roads, hence exacerbating the problem. To address these challenges, government designed a set of policy and legislative frameworks seeking to 'green' the transport industry. To review government's performance in this regard, this paper identifies and discusses these frameworks using fuel quality, fuel economy, fuel switch and technology switch as main criteria. South Africa's performance is benchmarked against related frameworks in other major transport greening regions. The paper adopted a qualitative approach, relying on data sourced primarily from documents and analysed qualitatively using content analysis techniques. Based on globalisation, interventionist and sustainable development theoretical constructs, the paper argues that this country still lags behind from the world on these transport greening matters. While examples of good practice in the form of fiscal and monetary incentives exist, these only provide indirect stimulus for green transport-related goods and services. Due to the existence of many competing priorities, the paper therefore argues that, there is a need for policy measures that first clarify all drives to the green transportation transition. These should clearly highlight the desired end result way before a decision on the best path, is taken. Through the use of appropriate decision support tools, a technology path should then be selected. Two paths that often get followed at international level include technology neutrality and technology picking. Any chosen path should then be supported through specific incentive mechanisms targeting both the demand and supply sides. In a developing country like South Africa, where both development and environment protection agendas are equally important, technology picking is discouraged as this is likely to address only one or just a few areas of national importance. The paper recommends that in such cases, a technology neutral route should be followed. Nonetheless, the ultimate decision should be dictated by the outcomes of the decision support tool utilised.

KEY WORDS: fossil fuels, pollution problem, transport greening, policy routes, support incentives, globalisation.

APPENDIX I:
CONFIRMATION OF THESIS PROOFREADING

KIM WARD
Proofreader & Editor

81 William Younger Drive
Hilton, 3201
SOUTH AFRICA

Tel: 033 3431241
071 4233468
kimw@c-s-v.co.za

To whom it may concern

4 August 2020

This letter serves to confirm that I have proofread the PhD thesis:

TOWARDS A GREENER ECONOMY: A CRITICAL REVIEW OF SOUTH AFRICA'S POLICY AND LEGISLATIVE RESPONSES TO TRANSPORT GREENING

by Phillip Gcinumthetho Ninela.

Yours faithfully,

Kim Ward
BA (Hons) English – University of Natal, 1995
Masters (Education) – Rhodes University, 1998