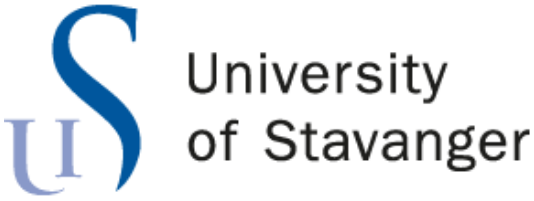
ELECTRIC VEHICLES TRANSITION IN DEVELOPING COUNTRIES; A CASE STUDY OF NAIROBI-KENYA

Masters Thesis by Francis Adjei-Ampomah

Thesis submitted in fulfilment of the requirements for the degree of Energy, Environment and Society.



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ABSTRACT

Automobility is confronted with the need for change to address the persistent problems such as increasing traffic congestion and atmospheric pollution (including emissions that contribute to climate change. In practice, the rapid and increased warming of the global average temperature to 1.5 ° C poses a challenge to earth systems and this phenomenon is largely due to the high level of vehicles powered by fossil fuels, mainly diesel and petrol, that has dominated the automobile landscape.

This has challenged policymakers, politicians, businesses, organizations, civil society groups to identify more sustainable automobility options. Therefore, the aim and purpose of this thesis is to assess the possibilities of an electric vehicle transition in Nairobi-Kenya, using the MLP as a theoretical point of departure. The thesis briefly highlights on the application of the MLP in EV transitions in developed countries such as Norway and Sweden and compares with the situation in Nairobi-Kenya.

In principle, the thesis explores the three analytical levels of the MLP and analyses the interplay of these levels in the context of Kenya. The findings of this study suggest that, although climate change is the dominant factor in EV transition in developed countries, high cost of crude oil is the dominant landscape factor in the case of Kenya. It describes also, the regime actors and highlights on Kenya's EV niche actors, namely Nopea Ride and Opibus. The thesis goes further to craft or propose an MLP which fits into Kenya's EV transition.

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"Family is not an important thing. It's everything" Michael J. Fox

To my mum, dad and siblings for their love, advice, encouragement, support and hope for my bright future made it possible for me to complete this unimaginable journey to excel and graduate with a masters degree. I am so grateful to them for this achievement.

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ABBREVIATION

BAU- Business As Usual

BEV/BEVs- Battery Electric Vehicle(s)

CEO- Chief Executive Officer

CO_2- Carbon dioxide

EMCA- Environmental Management & Conservation Act

EU- European Union

EV/EVs- Electric Vehicle(s)

GDP- Gross Domestic Product

GHGs- Greenhouse gases

GIZ- Deutsche Gesellschaft fur Internationale Zusammenarbeit

ICE/ICEs- Internal Combustion Engine(s)

KRA- Kenya Revenue Authority

MENR- Ministry of Environment and Natural Resources

MLP- Multi-level Perspective Framework

NDC- Nationally Determined Contribution

NGOs- Non-governmental Organizations

NSD- Norwegian Centre for Research Data

Sq km- square kilometer

UNEP- United Nations Environment Program

USD- United States Dollar

VOC/VOCs- Volatile Organic Compound(s)

CHAPTER ONE: INTRODUCTION

1.1 Introduction

There is scientific and political agreement that the world's consumption of fossil fuels must be phased out, due to both the threat of destructive climate change and the future shortage of available fuels. The Paris Climate Change Agreement also advocates that in order to curtail climate change and the challenges that comes along with it, there is the need to reduce our carbon footprints significantly.

The transport industry constitutes a key component of social and economic development globally (Gudmundsson et al., 2016). According to the International Energy Agency (2010), presently, the industry, accounts for about 27% of total global energy consumption, and this is expected to rise by 50% in 2035.

However, the transport industry over the years has undergone series of system changes. The overwhelming effects of climate change, in the form of unprecedented change in weather and climate patterns have challenged mainstream policy makers to act swiftly to mitigate the effects, as well as promoting sustainable development at all levels within their respective countries (Rietmann & Lieven, 2019; Vagnoni & Moradi, 2018).

On the global level, vehicles powered by fossil fuels, mainly, diesel and petrol, thus internal combustion engines (ICE) have dominated the automobile landscape for a significant period of time and has created a huge environmental impact on delicate ecosystems.

These effects are in the forms of traffic congestion, public transport inadequacy, high infrastructure maintenance costs, environmental impacts and energy consumption (Moradi et al., 2018).

The economic implications of this development is significant. Kenya has currently 3.2 million vehicles with 2 & 3 wheelers presenting the large share of the vehicle fleet (see Table 1.1) and holding the highest rate of motorization with 108,000 new registered in 2018 (DW, 2019).

The Economy Watch (2020), states that the government of Kenya spent about $3.05 billion on oil imports, with each liter of fuel consumed by motorists costing around 110 Kenyan shillings. In detail, it is said to cost Kenya about 50 million shillings in lost productivity daily (Ahmed, 2019).

As a result of this, policy makers have considered electrification of vehicles as a pragmatic and a key policy goal to address the consequences arising from over-reliance on fossil fuels, recognized as having negative impacts on environmental conditions as well as damaging human health (Casals et al., 2016; European Environment Agency, 2016; Günther et al., 2015;Wu et al., 2018).

Nonetheless, the rationale of governments to take a national action has been driven by energy, environmental and economic pressures at the global level, where it is believed that about $13-16 billion investments have been made in policy formulation programs and incentive packages to create a cost competitive and enabling business environment for electric vehicles (*Global EV Outlook*, 2015; Hao et al., 2014; Wesseling, 2016).

According to United Nations Data (2015), Nairobi has an estimated population of 3.915 million and an area of 696sq km. The city, which is also the financial, diplomatic and communications capital of Kenya, has both an urban landscape and green spaces, thus comprising of national parks with significant black rhino and other wildlife population. Interestingly, wildlife landscape and safaris attracts lots of tourists yearly to the Kenyan capital (UNCTAD, 2016).

The transport sector constitutes one of the fastest growing sectors in Kenya, with an average growth rate of 12% per year for light duty vehicles (Ehsani & Mwaniki, 2017).

In detail, the United Nations Environment Program (2006) asserts that, the overall amount of petroleum products demanded by the sector is expected to surge from around 1.9 million tons as recorded in 2004 to around 8.6 million tons or 5.3 million tons and 6.8 million tons by 2030.

However, the threat and risks regarding sustainability is not so much the quantity of hydrocarbon resources present, but the combination of environmental and economic costs of the use constitute the main problem (Greene & Wegener, 1997).

Going forward, the Kenyan national determined contribution (NDC) of a 30% reduction of emissions by 2030, strongly undermines its ability to increase demand levels for fossil fuel resources (International Energy Agency, 2014). Yet, there is significant growth in conventional vehicle fleet in the country with the current vehicle population standing at over 2.5 million, whereas average number of newly registered vehicles exceeds 200,000 annually since 2014 (Kenya National Bureau of Statistics, 2019).

With the current speed at which Industrialization and development is unfolding in developing countries, such as Kenya, it is expected that, the number of electric vehicles and other automobile elements are to increase, and this will be largely dependent on balancing the interplay of consumer pull and regulatory push, as well as firms capacity to reconfigure their value propositions (Bohnsack & Pinkse, 2017).

In this regard, the electrification of vehicle is therefore crucial in addressing the numerous challenges that comes with continuous dependence on fossil fuels, thus increasing cost of fossil fuels supply, declining environmental quality as well concerns over the future of the supply in general.

According to Golembiewski et al. (2015) and Kiechäfer et al. (2017), the substitution of dominant technological systems, thus international combustion engines, have prompted businesses to restructure their conventional value chain and operation strategies.

Inspiringly, there's been a huge success with electric vehicle transition across Europe, in countries such as Norway, Denmark, Sweden and Germany. Obviously, the successes in these countries is hugely dependent on the strong advocacy for battery electric vehicles in climate policy. A typical example is Norway (Figenbaum, 2017).

Furthermore Figenbaum et al. (2015) notes that, tax cuts, as well as non-tax incentives in the form of free toll roads, free battery charging as well as free parking in public places have been very pivotal in the success of Norway. Whereas in Denmark, the introduction of tax system which penalizes heavy polluting internal combustion engines helped significantly to boost electric vehicle market (Christensen et al., 2012).

The situation is different in developing countries. Kenny (2009) notes that, usually, government investments in transport stands between 2% and as high as 3.5% of total GDP in developing countries.

In the midst of tighter economic budgets, low technological competence, and more pressing social issues such as poor health conditions of people, high unemployment rate, inadequate educational infrastructure, it becomes quiet difficult for policy makers and politicians in this region to invest heavily on electric vehicles, even though the region suffers the most from the consequences of climate change.

Hence, this thesis, is driven by Kenya's initiative, being a developing country, to invest significantly in electric vehicles amidst pressing social issues and more importantly to also bridge

the gap in academic and policy literature, where a larger volume of work been done on socio-technical transitions using the MLP focused on developed countries mainly (Kester et al., 2018).

Emphatically, it will investigate why and how electric vehicles have entered into Kenya's transportation landscape, the current state of the transition and how the political framework, stakeholder activities and international developments have interacted to create such an environment. It is informed by research from government reports, policy documents, scientific studies, interviews and expert opinions as well as case studies.

Table 1. 1: Projected increase of motorization rate in Kenya from 2015-2050

	2015	2020	2030	2040	2050
Passenger car (PC) stock [-]	532,406	745,304	1,297,828	2,101,272	3,142,422
Inhabitants [in 1000]	46,050	53,115	67,245	81,375	95,505
Motorization rate [PC per 1000 inhabitants]	11.56	14.03	19.30	25.82	32.90

Source: SIEMENS Stiftung, (2020, p. 11)

1.2 Problem Statement

It is important to know that the nature of socio-ecological system has changed fundamentally over the course of human history, as we have generally developed new technologies, institutions and tapped into new energy sources.

Undoubtedly, the transportation sector contributes greatly to global warming and climate change. The resultant effects of climate change on the other hand has prompted a transition towards carbon free fuel vehicles or other flexible fuel vehicles, in replacement of the usual gasoline and diesel vehicles (Granovskii et al., 2006; Mansour et al., 2017; Orsi et al., 2016).

However, Gordon et al. (2013) further states that, transportation by road, unequivocally has the utmost negative impact on the climate, and this is as a result of two main factors, which includes, the nearly exclusive dependence on petroleum fuels in which the combustion process produces high levels of greenhouse gases (GHGs) and secondly nominal emissions of sulfates, aerosol and organic carbon from on-road sources to counter balance warming with cooling effects.

In Africa, Nairobi is the worst and fourth on the global scale in terms of overall inefficiencies in traffic system (Traffic Index, 2019). Thus far, there are concerns by the general public on the high pollution levels within the city as well as the increasing cost of transportation, mainly due to the sudden fluctuations in gasoline prices in the global market.

Moreover, Kenya's energy supply has been characterized by a very low access to energy, yet a very sustainable energy mix (See Figure 1.1) and a positive outlook for renewable energy (Kiplagat et al., 2011).

From this perspective, there's been efforts to consider other alternatives which would be geared towards tackling increasing CO_2 levels, as well as high cost of transportation within the region.

In detail, a much more sustainable transport system will be required. This new transport system must provide mobility and accessibility to all urban residents in a safe as well as an environmentally friendly manner. Gloomily, this approach or strategy is ambiguous, particularly when the needs and demands of different income groups are not only dissimilar but also paradoxical (Mohan & Tiwari, 1999).

However, major academic literature on electric vehicle transitions and related discourse seem to be more focused on the developed countries like Norway, Denmark, Sweden and Germany, For example, Tran et al. (2012) did a study on realizing the electric vehicle revolution, where one of the assertions made was that, the emergence of alternative fuel technologies could threaten the diffusion of BEVs in developed markets. Amongst other equally important arguments raised, it advocated for a more integrated approach to decarbonize transport systems that will be centered on both technical and behavioral paradigms.

Moreover, Figenbaum et al. (2015) argues that, the introduction of incentives by the Norwegian government contributed significantly to the success of EVs in the country, by removing barriers, therefore making EVs diffusion much easier.

In addition, Casals et al. (2016) text on sustainability analysis of the electric vehicle use in Europe for CO_2 emissions reduction, further, pointed out that, the rolling out of EVs constitute a key strategy in reducing the net GHG emissions, and that a number of countries within the EU have fairly good energy mixes that could accommodate EVs.

Considering the significant role played by politics in socio-technical transitions, Langhelle et al. (2019) argued that, mobilization of powers through state politics is crucial in ensuring rapid and

decisive societal change. Hence, social technical transitions can be said to be dependent on how far societal changes are politicized.

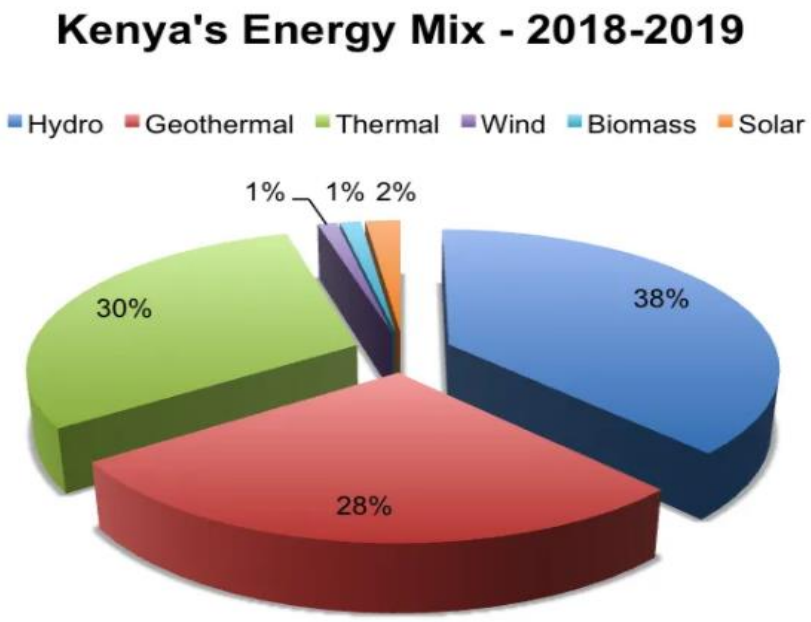
In all of these studies, the underlying concept is the fact that electric vehicles are a promising alternative to internal combustion engines and an important milestone towards a zero carbon transportation sector and reducing the adverse effects of global climate change.

Nonetheless, low social and market acceptance of electric vehicles, and the high dependence on carbon intensive energy mixes in most countries makes the socio-technical transitions difficult (Klemola & Karvonen, 2016; Oltra & Saint Jean, 2009).

However, despite excellent work on the above mentioned articles on socio-technical transitions, scholars have not addressed the topic in question, that is focusing on socio-technical transitions in developing countries and this poses a gap in the literature.

As a result, this thesis will fill the gap created by assessing electric vehicle transition in Kenya and more importantly, contribute to the MLP literature, by applying the framework to a developing country context.

Figure 1. 1 : The Energy Mix of Kenya 2018-2019



Source; (African Strategic-Ventures, 2020)**.**

1.3 Research Questions

Consequently, three research questions are formulated as follows:

1. What are the main barriers/challenges for an EV transition in Kenya?
2. What could speed up EV transition in Kenya?
3. Is the political, environmental, economic, cultural and social climate favorable for a faster EV transition in Kenya?

1.4 Research Objectives

The purpose of this study is to analyze electric vehicle transition in Nairobi- Kenya, taking into consideration the MLP as the theoretical point of departure. However, other factors that would be considered and brought into focus would include the energy mix of Kenya, tighter economic budgets, high cost and technicalities that comes with emerging technologies.

1.4.1 Specific Objectives

Specifically, the study seeks to understand the extent of political support for electric vehicle transition in Kenya and to determine clearly, how electric vehicles could destabilize existing regimes (internal combustion engine vehicles) in Kenya's transportation sector, in the context of the MLP on socio-technical transitions.

1.5 Background of the Study

In addressing issues regarding socio-technical transitions, it is crucial to acknowledge broader concepts such as sustainable development. The concept has been quoted a million times in recent academic and policy literature globally. Yet, it is heavily contested on several platforms amongst policy makers, politicians, institutions, researchers, civil society groups and individuals.

According to WCED (1987), sustainable development refers to the "development that meets the needs of the present without compromising the ability of future generations to meet their needs". In basic terms, the goal of sustainable development is to meet the needs of today, without compromising on the needs of tomorrow.

This implies that, we cannot continue using current levels of resources as this will obviously not leave enough or sufficient for the future generation. Although, the United Nations Sustainable Development Goals, clearly have addressed sustainability concerns over the past years, much more needs to be done, considering the speed at which industrialization is taking place in all regions across the globe.

In principle, the consequences of industrialization have had significant effect on air quality. Considering human history over the years, air pollution was largely local and low in terms of scale. But the 20th century brought about exponential increase in heating, power generation, metal smelting, motorized transport, waste incineration and other human activities (McNeill, 2001).

The increasing industrialization levels also implies an exponential increase in energy use. As a result the choice of energy have obviously become a key factor of the world's environmental condition. This is evident in ways such as species loss, air and water pollution and deforestation, coral reefs die-offs, fisheries depletion and wetland losses (McNeill, 2001).

In developing countries, clearly industrialization is unevenly distributed, that is to say that, industrialization often takes place in the bigger cities. This phenomenon translates into rural-urban migration, where large groups of people move into these areas to take up employment and other opportunities that is available in the bigger cities.

With these large crowds of people moving into the bigger cities, it is obvious that, vehicular traffic will increase, and therefore sustainable transport options would be crucial in addressing deteriorating environmental conditions in these regions.

In this regard Figueroa et al. (2013) argues that the growing motorization levels in both developed and developing nations is crucial in both environmental and economic paradigms and hence

prompts the need of finding ways to meet the growing passenger demands as well as addressing deteriorating environmental conditions.

Presently, mobility demands in low income countries and other peripheral areas have failed to address the demands of formal public services. Unfortunately, certain group of people within these areas could be marginalized as a result of inadequate transport services, through difficulty in commuting to their workplaces, learning and accessing healthcare services (Jayaprakash et al., 2009). As a result, these people are compelled to rely on informal modes of transport as a way of meeting the gap in transportation systems (Cervero & Golub, 2007).

Also, in low income countries, large group of people mostly within the urban cities where transportation is costly, rely on walking and bicycling. Sadly, there's inadequate and sometimes no developed infrastructure to support these modes of transport (Pendakur, 2011). The situation in Nairobi-Kenya, is obviously not different from this, as large parts of the city have less infrastructure to support walking and biking. As such, safety becomes a crucial matter of concern to bikers and pedestrians in these communities (Heinen et al., 2010).

The transition of fossil fuel run vehicles to electric vehicles is recognized as a key strategy in addressing the effect of the transportation sector on climate. Globally, EV's has been growing more rapidly in the past few years, with the global stock level passing 5 million in 2018, thus, an increase of 63% from the previous year (IEA, 2019).

In detail, electric vehicles have made a fairly good penetration in parts of Europe and China, that they had gone beyond 1% market share in China and six other European countries for new sales (International Energy Agency, 2016b). By 2017, these countries had gone beyond a 2% and some

even gone much further- Sweden stood at 5.3%, Iceland 14% and Norway 39.2% (European Alternative Fuels Observatory, 2018).

In Kenya, currently, electric vehicles is far below reaching a 1% market share of the net vehicle fleet. Yet, to ensure that technology transfer or change is effective in reducing carbon emissions significantly in the long term, the transition should be part of a broader process of technological change (Ockwell et al., 2008).

Nonetheless, this figure is expected to improve significantly in the next couple of years, where electric vehicles is expected to compete the existing industrial structure and challenge dominant industrial logistics (Song, 2017).

1.6 Chapter Organization

This thesis is divided into six parts. Following this introduction chapter is Chapter 2. Chapter 2 is the Literature Review chapter, Chapter 3 describes the Research Theory and Analytical Framework, Chapter 4 describes the Research Design and Methodology, Chapter 5 applies the MLP in the context of Kenya and Chapter 6 covers Conclusion and Recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1 Sustainable Development and Planetary Boundaries

The effect of fossil fuel combustion from transport services raises concerns with respect to the sustainable development goal 13, which emphasizes on the need to embark on a climate action. Interestingly, Nairobi is growing rapidly and transport services as well as emission levels are expected to rise significantly. As a consequence Lall et al. (2017) argues that, Kenya's economy is undermined by the traffic congestion caused by insufficient road infrastructure.

Sustainable development is a contested concept, however, the focus of sustainable development is to effect a change and the implications of that change are mostly witnessed when the concept is contrasted with other cases where the term "sustainable" has been applied (Langhelle, 1999).

In practice, sustainable development is the development that meets the needs of the present without compromising on the ability of the future generation to meet their needs (WCED, 1987). The continuous development of the human environment and protection of the earth's systems should call for a new paradigm shift that integrates these concepts in a much more resilient state (Steffen et al., 2015).

Going forward, the planetary boundary framework is however seen, as a contributor to such a paradigm as there is much of a science based analysis of the potential risks involved as a result of human actions and their effects on undermining the earth system on the planetary scale.

Technically, climate change and planetary boundaries are putting pressures on existing socio-ecological systems. As a result, Steffen et al. (2015) argues that, these pressures or stress threatens

the resilience of the earth system, That is, its ability to maintain critical thresholds in the presence of challenges such as human pressures and shocks.

2.2 Sustainable Transport

In basic terms, transportation denotes the movement of people, goods and services from one point to the other, Meira et al. (2020) and Rizzi & De La Maza (2017) notes that, sustainable transport refers to a shift away from traditional transport systems and policy frameworks to greener transport options.

According to WCED (1987), one of the key constituents of sustainable development is for its rates of pollution emission do not exceed the assimilative capacity of the environment. With transport, being a large component of economies, it is obvious that, it has undesired effects on components of the environment such as air, water pollution, noise pollution and habitats destruction (US Department of Transportation, 1996).

In detail, a variety of pollutants including carbon monoxide, volatile organic compounds (VOC) and other oxides of nitrogen are emitted into the atmosphere as a result of incomplete combustion of petroleum fuels in internal combustion engines (Walsh, 1993).

With pollution from these vehicles having significant local and regional effects. They transcend to global scales and contribute significantly to global environmental problems. More critically, is that oxides of nitrogen and sulphur react which causes acid rain, which has a significant negative effect on both aquatic and terrestrial ecosystems (Greene & Wegener, 1997).

Also, International Panel on Climate Change (1996) stresses that, fossil fuel combustion and use, land-use changes, and agricultural activities have resulted in about 30% increase in carbon dioxide concentration in the atmosphere globally. Going forward, they add that anthropogenic activities

have also contributed significantly to global climate change, thus an increase in the global mean temperature from 0.3℃ to o.6℃ since the late nineteenth century. However, the continuous reliance on fossil fuels for transport and other uses will surge temperature levels within the next few decades.

Generally, people have showed massive support towards sustainable policies geared towards reducing car use, thus people who prioritized the environment, perceived car use reduction as a moral obligation (De Groot et al., 2008; Jakovcevic & Steg, 2013; Meira et al., 2020; Ünal et al., 2019). The sustainable mobility approach highlights on the need to ensure fewer trips, encourage modal shifts, reduce trip distance and encourage maximum efficiency in the transport system (Banister, 2008).

In detail, the broader participation and involvement of society is crucial in the planning, implementing, monitoring, and evaluating sustainable mobility policies. Unfortunately, the participation of society in most developing countries has been minimal. Among other things, the governance period by democratic governments and mainstream policy makers is inadequate to initiate strong and effective political and institutional systems to oversee sustainable transport policies (Meira et al., 2020; Oliveira, 2006).

2.3 Understanding Energy and Sustainability Transitions

Considering environmental, social and economic dimensions of current energy systems, it is convincing enough, that the current energy systems are unsustainable and hence the need for a transition (Grubler, 2012). This calls for an urgent need for the global community to make amendments in the current energy systems, hence the need to transition towards a more cleaner and carbon free energy systems (Riahi et al., 2012; Sovacool, 2016).

The deep structural and systematic changes in these systems are referred to as 'socio-technical transitions' as they involve significant changes in the overall structure of transport, energy and agri-food, which takes into account technology, policy markets, consumer practices, infrastructure, cultural meaning and scientific knowledge (Elzen et al., 2004;Geels, 2004).

However, both public and private institutions within our communities seem not to be motivated enough to cause a change in terms of energy use. Nevertheless, there is substantial literature which proves that successful energy transitions is heavily dependent on the ability to overcome existing barriers that extends beyond technological and economic parameters (Geels, 2005), while considering other factors such institutions, infrastructure and society as being equally important.

More importantly, in addressing persistent environmental problems, sustainability transitions are goal oriented (Smith et al., 2005). By this, a number of policies and strategies are implemented in countries and they are crucial in addressing the persistent environmental problems in these countries. In Kenya, the NDC represents the commitment and support for adaptation actions, and this is discussed in detail, in the next section.

2.4 The Nationally Determined Contribution of Kenya

Following the Paris Climate Change Agreement, Kenya submitted its Intended Nationally Determined Contribution (INDC) on July 23, 2015, and subsequently, ratified the Paris Agreement on December 28, 2016. Hence, the INDC became the NDC of Kenya (Luna, 2018).

Mitigation and adaptation are key components of Kenya's NDC, and commitment and support for adaptation actions is crucial for strong mitigation actions (MENR, 2015). Key amongst the

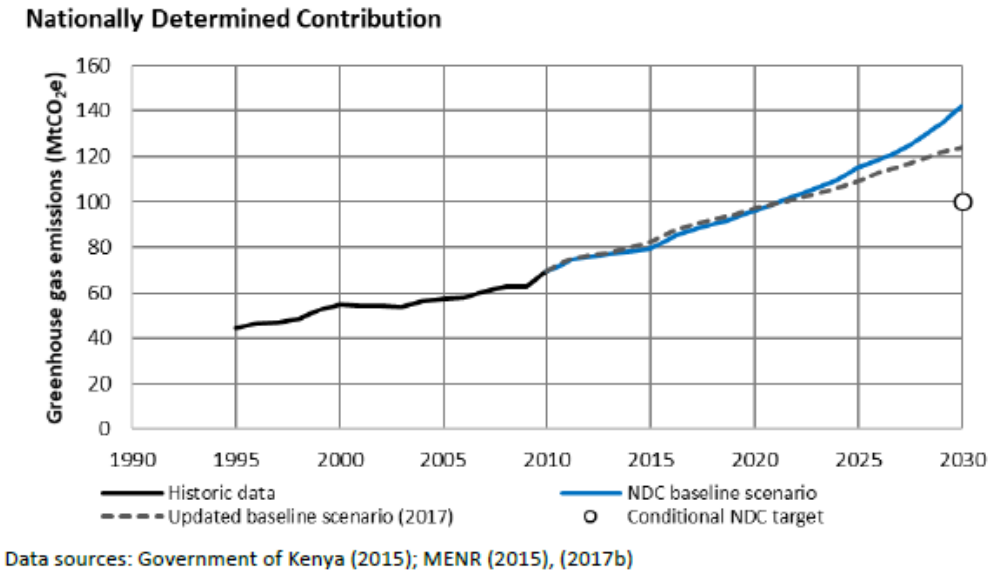
numerous mitigation measures includes expansion in renewable energy options, climate smart agriculture and sustainable waste management systems (Luna, 2018). Low carbon and efficient transportation systems remains crucial and clearly indicates Kenya's government support for new technologies and innovations including electric vehicles.

In detail, Kenya has set out a 30% reduction, below Business as Usual (BAU) in 2030, which is referenced to a BAU scenario of 143 $MtCO_2e$ in 2030. This implies a target of 100 $MtCO_2e$ in 2030. Reaching this target would result in 43% increase in Kenya's emissions from 2010 levels (Luna, 2018). The electrification of transport, therefore, would contribute significantly to this development.

Interestingly, the Ministry of Environment and Natural Resources (MENR) updated the emissions projections for Kenya in 2017, based on updated inventory data, new electricity forecasts, and new economic growth models, bringing the country 43% of the way in reaching the set target. However, the Kenyan government has clarified that, regardless of the updated baseline, the set target remains resolute and referenced to the BAU scenario specified in the NDC (Luna, 2018).

Below, is the graphical representation of Kenya's projected emissions and NDC targets.

Figure 2. 1: The NDC of Kenya



Data sources: Government of Kenya (2015); MENR (2015), (2017b)

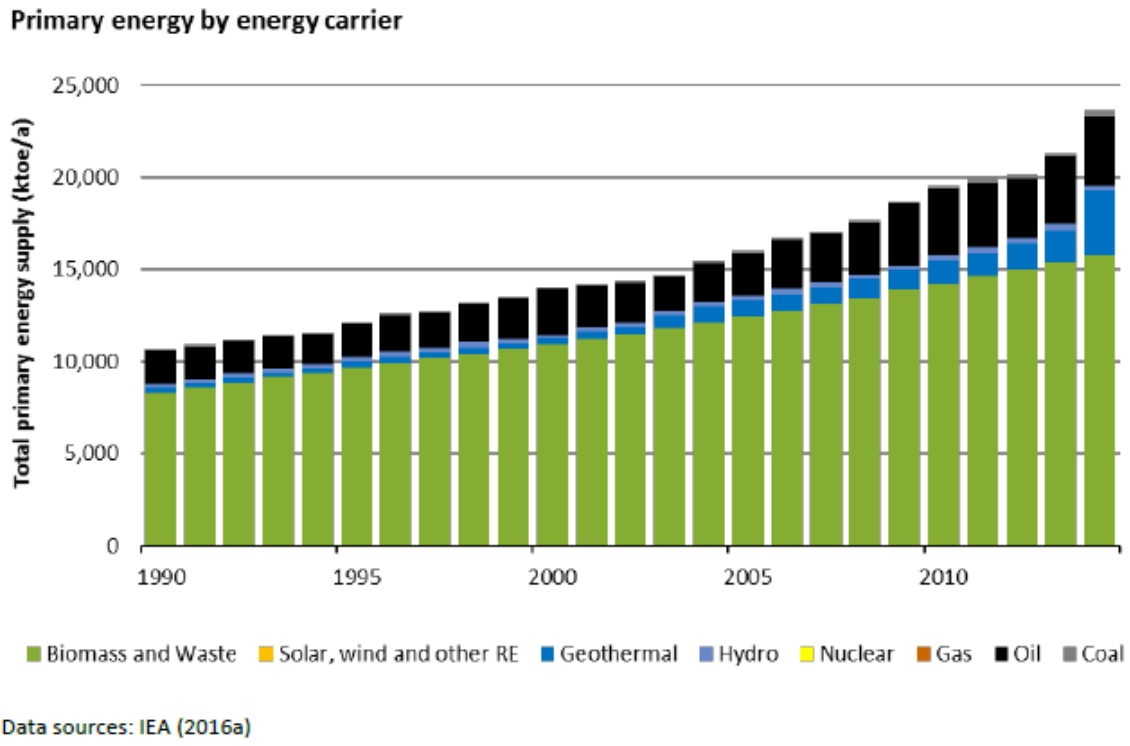
2.5 The Energy Mix of Kenya

Undoubtedly, the success of electric vehicle transition is dependent on reliable energy supply. In addition, since climate concerns are crucial and amongst the forces exerting pressure on society's to transition towards new technologies, environmentally friendly energy sources are encouraged.

According to IEA (2020), About two-thirds of Kenya's energy currently comes from bioenergy, and with the continuous use of geothermal and oil resources, this share shrinks to 15% by 2040. For domestic purposes, Kenya's forest provides wood fuel and charcoal to homes for cooking. However, the over reliance on forest resources for energy over a long period of time has resulted in large scale deforestation (Luna, 2018).

In reality, the residential sector consumes more energy than any other sector, accounting for about 75% of all energy consumed in 2014. Whereas, transport and industry accounts for 15% and 8% respectively (International Energy Agency, 2016a). Below, is the diagram showing Kenya's energy mix from 1990-2010.

Figure 2. 2: The Energy Mix of Kenya 1990-2010



Data sources: IEA (2016a)

2.6 How Developing Countries' Cities Differ

2.6.1 Pre-mature congestion

The issue of congestion in developing countries cities continues to be a major concern. In most of the megacities in developing countries, congestion is endemic and this can be associated with the downtown weekday traffic speeds that are recorded to average 10km/h or less in Bangkok, Manila, Mexico and Shanghai and 15km/h or less in Kuala Lumpur and Sao Paulo (Gwilliam, 2003).

A number of developing countries have about 100 cars per 1000 people compared with about 400 or even much higher in the developed countries. It is therefore obvious that, the relationship

between income and car ownership in developing countries is actually in parallel with the patterns of the developed countries such as The UK, France, Japan and Spain (Gwilliam, 2003).

Nevertheless, countries such as Argentina, Brazil and Mexico and other transition countries have much higher car ownership-to-income ratios than experienced by the industrialized countries. Due to this, congestion is said to be pre-mature (Gwilliam, 2003).

2.6.2 Deteriorating Environment

Declining environmental quality and conditions continues to persist in developing countries (Gwilliam, 2003; Hughes & Lovei, 1999). In the case of Kenya, GHG emissions have contributed significantly to deteriorating environmental conditions over the past years.

Luna (2018) argues that, within 1995-2010, net emissions from agriculture, land use, forestry, energy, waste and industry in Kenya have increased by 56%. Interestingly, per capita emissions remained relatively stable, fluctuating between 1.5 and 1.8 $MtCO_2$ per person.

Below, is a table showing Kenya's emissions, energy and environmental data. From the table, it shows clearly that Kenya's total emissions makes up 0.1% of the World's total emissions.

Table 2. 1: Kenya's Emissions, Energy and Environmental Data

Indicator	Kenya	% change since 1990	World	Germany	Year
GHG/cap [tCO2e/cap]	**1.5**	*-8%*	6.42	10.8	2014
GHG/GDP [tCO2e/mln 2017 USD]	**1,082**	*-76%*	593	225	2014
Energy/GDP [ktoe/mln 2017 USD]	**0.38**	*-69%*	0.17	0.08	2014
Global share of emissions [%]	**0.1%**	*0%*	100%	1.8%	2012
Air pollution index (P2.5)	**16**	*1%*	42	14	2014
Vulnerability index [0 – 1]	**0.53**	-	-	0.23	2014

Data sources: IEA (2016b); World Bank (2017); ND-GAIN (2017); Gütschow et al. (2016). GHG indicators were calculated using PRIMAP data and exclude contributions from the LULUCF sector.

2.6.3 Safety and Security

The issue of safety continues to be a challenge in most cities within developing countries. Transported related injuries and crime rates are undoubtedly high. Moreover, it is reported that, annually, about one million people die by road accidents. Interestingly, about 85% of these cases are from the developing countries and transitional economies, and most of these cases are reported in the cities (Gwilliam, 2003).

Globally, road related casualties currently stand between 25-35 million. However, 75% occur in the urban centers. The most reliable indicator in addressing safety concerns is the mortality rate per vehicle, which decuples mostly in cities within developing countries, as compared to cities within industrialized cities. Thus, the issue of security is very crucial and directly affects private car users, public transport vehicles as well as pedestrians and cyclists (Gwilliam, 2003).

Also, the lack of insurance policy, compensation plans, and social security in developing countries further increases the trauma and the vulnerability of victims hence influences greatly on the general

public who tend to avoid vulnerable modes and times of travel. Consequently, leading to declining travel rates as experienced in Sao Paolo and other cities (Gwilliam, 2003).

2.6.4 Declining Transport for the Poor

In cities in developing countries, there's the unequal distribution of transport infrastructure and other facilities, this can be seen in several ways, some of which include; the fact that poor people are often located in marginalized and unwelcoming areas within the cities, coupled with poor transport systems in the form of walking, and no public transport (Gwilliam, 2003).

According to Sachdeva (1998), all major trips in the cities in India are basically non-motorized and around half of the cities in Africa is poorly served. A crucial example is India, where most roads usually have no pavements and the ones with pavement are mostly occupied by street vendors, shops, or blocked by cars, motorcycles and bicycles. However, public authority attitudes with regards to bicycles have been very clear and, in some cases, some governments, especially Indonesia, have taken actions to eliminate non-motorized public transport systems.

To conclude with, traditional buses have obviously been key in many urban transport settings, carrying about 6.5 trillion (6.5×10^{12}) passenger-km annually in 3 million vehicles, out of which over 2 million operate in cities. Operators of these local transport systems, often described as being traditional monopoly bus operators, regardless of being private or public, have collapsed (Gwilliam, 2001).

Unfortunately, in Africa, they have been heavily replaced with a disintegrated small vehicle paratransit sector, whilst in Eastern Europe and Central Asia, there is process of decline at various stages within the process. The difference with the public transport landscape, however, is the fact

that they're coupled with fare control policies, designed to shield the less privileged (Gwilliam, 2003).

2.6.5 High Spatial Concentration of Population and Income

In many African and Asian countries, city size distribution is highly uneven. Considering high populated countries, such as the Philippines and Malaysia, income and economic activities are unevenly distributed. Therefore, it is obvious that, even though Thailand, Chile and Korea and some other countries have lower motorization rates, capital cities within these countries are overpopulated and it is likely that with time, they may have much higher incomes as compared to the developed countries, and car ownership could also go beyond the national average (Gwilliam, 2003).

Clearly, the high population and overcrowding in these larger cities recommends dispersal of population. Nevertheless, since these overcrowded cities in most countries are the pivots for economic development, that is where large industries and companies are located, it becomes very difficult to push for dispersal.

Sadly, successive attempts geared towards dispersing these larger cities have failed in most cases and hence it is advisable that efforts are directed at strengthening markets and making them work closely together, rather than administrative efforts to disperse these geographical regions. Therefore, authorities should consider improving transport and communication systems in these areas (Gwilliam, 2003).

2.6.6 Weak Traffic Management

Wider mix of traffic in many countries has resulted in unsuccessful traffic management. In addition, other factors such as lack of adequate planning and implementation skills, and low status

of traffic management within city bureaucracies, has also been contributory factors in this menace. However, traffic management systems has also been ineffective in some communities, due to weak institutions. For example, In Bangkok, police personnel have in some cases ignored traffic signals and that has made it difficult to introduce a stronger traffic system (Gwilliam, 2003).

2.6.7 Poorly Developed Municipal Fiscal and Regulatory Institutions

In recent years, the expenditure responsibilities of municipalities have increased significantly much more than the intergovernmental transfer of funds, because of the decentralization of urban transport responsibilities to the cities. It is important to note that, the capital and current expenditure of cities have to be expanded since only a small percentage of the financial resources needed comes from multilateral and bilateral agencies and organizations (Gwilliam, 2003).

Also, the privatization of telecommunications, water and other utility motivates a number of societies that urban transport can be financed privately. Unfortunately, access tends to limit the scope for private financing of roads whereas shadow tolls, especially those introduced in Europe leaves a cost on budget. Nevertheless, in the case of developing countries, all private financing attempts have not been successful (Gwilliam, 2003).

2.6.8 Dealing with the High Polluters

In reality, weak and poorly maintained vehicles contribute significantly to the nonsymmetrical share of total vehicle emissions. According to Gwilliam (2003), minor repairs improved fuel economy by an average of 17% and reduced emission levels by 44%. Investing in lubricants, therefore would provide users with both environmental and economic (cost) benefits (Gwilliam, 2003).

Another key strategy to deal with pollution and emission levels, is to invest substantially on inspection and maintenance exercises. Nevertheless, corruption and technical difficulties makes it complex to design and regulate a well-run inspection and maintenance program, yet, the merits are very significant when designed, as it helps reduce emission levels. It is therefore, important that countries invest in a computerized emission measurement systems which minimizes tempering and they are more effective than decentralized systems in which large private garages are involved (Kojima & Bacon, 2001).

To ensure that, weak and poorly maintained vehicles that are usually high polluting leave the transport system, vehicle scrappage, and replacement incentive payments should be introduced to encourage users of these vehicles to discard them. In Hungary, this approach has been realistic when directed towards the heavy good vehicles markets, where old cars were phased out and replaced with new cars (Gwilliam, 2003).

2.7 Nature of the Urban Transport Problems of the Poor

Globally, poor people make less travels than the non-poor. It is known that the trips made by poor people are about 20-30% less per capita less than the non-poor. In many low income communities, private motorized trips are made by only few sections of the population who can afford it, whereas, low income earners, rely on motorcycles. This suggests that, in almost all communities, the non-poor spends higher, in terms of their net earnings on transport than the poor (Gwilliam, 2003).

However, considering the aforementioned income dynamics, it is obvious that transport is crucial and a key instrument of the poverty problem of people living in low income countries. In most cases, poor people often choose to live in barely habitable conditions and environments, because of easy access to their workplaces. For example, in many Brazilian cities, people live close to their workplaces, yet they are no formal means of transport available to them (Gwilliam, 2003).

In worst cases, low income earners are challenged with high travel costs and longer travel times due to the fact that they live further away in order to pay less for accommodation. In Mexico City for example, about 20% of workers spend more than three hours travelling to and from work, whereas about 10% spend more than that (Schwela & Zali, 1999).

Indeed, such remote accommodation facilities lack vital urban facilities, and to some extent, requires, family and the overall neighborhood solidarity to overcome (Cusset, 1998). It is therefore crucial to understand that transport contributes significantly to improving the employment prospects of poor people.

Interestingly, a research carried out by the World Bank proved that, there is a direct proportion variation between the incomes of the poorest group in a population to the overall national income, yet it lacked evidence of a potential lag between increase of overall national income to the income of poor people to prove that, economic benefits trickle down only over a long period of time (Dollar & Kraay, 2002).

In addition, effectiveness of urban public transport infrastructure, service planning and investment should not necessarily be the ultimate pressing issues to governments, however, it is crucial for governments to consider transport, as a key component of social policy and hence address it in terms of transport pricing and financing policies through government expenditure and macro-economic stabilization programs (Gwilliam, 2003).

2.8 Technological Diffusion and Technological Change

There is a wide academic literature on technology transfer and technological change. The basic idea is the fact it involves the transfer of knowledge from one point to the other. According to

Schnepp et al. (1990), technology transfer is the process by which knowledge or expertise is transferred from one point to the other, mainly due to economic gains or benefits.

In the industrial revolution for example, several forms of industrial machines were overridden with much more complex and advanced systems which were more effective and efficient. However, with regards to low carbon technology, the economic benefits, refers to the mitigating or reducing the future cost associated with climate change and related effects, and not leaving out the financial benefits to the institutions and stakeholders involved (Ockwell et al., 2008).

More generally, the vertical transfer of technology that is from research and development stage, through to commercialization as well as horizontal technological transfer, in other words, delocalized transfer, from one geographical area to the other, constitutes a crucial element in the technological transfer literature.

As a consequence, Ockwell et al. (2008) argue that, both vertical and horizontal technological transfer is likely to happen in the case of low carbon energy transition in developing countries. This is largely due to the fact that, currently, low carbon technologies are pre-commercial, where there is a series of development processes towards commercialization with regards to the new country.

The effectiveness of low carbon technologies in developing countries is dependent on a number of factors. Although, public opinion may exert some form of pressure on policy makers, yet, this influence may not be automatic. Therefore, for responsiveness to occur swiftly, the challenges associated with fossil fuel oriented transport, which includes congestion, heavy pollution and high cost of gasoline has to be politicized by political groups and policymakers (Brouard & Guinaudeau, 2015). And not downplaying the fact that, to reduce carbon emissions in the long term,

technological transfer is crucial and hence must be a part of the broader processes of the technological change (Ockwell et al., 2008).

The processes through which these changes occur still remains crucial to several academicians in transition discourses. They could take the form of incremental or radical innovations or both (Freeman, 1992). Going forward, as industries and institutions strive to improve quality, design and performance, incremental innovations occur. This highlights the need for learning, whilst adopting a doing and interaction approach when dealing with suppliers and technology users (Freeman, 1992; Lundvall & Dosi, 1988; Ockwell et al., 2008).

On the other hand, consistent and deliberate research and development creates the environment for radical innovation to occur, and causes changes in existing production practices (Ockwell et al., 2008). Considering low carbon transport technologies for example, deliberate research and development led to the introduction of hybrid cars.

Previously, the vehicle fleet were dominated by gasoline vehicles which relied on the combustion engines technology solely, the hybrid vehicles combines both the internal combustion engine technology and battery driven electric motors. The resultant effect is that, they produce more effective and energy efficient vehicle, and in turn represents a radical innovation (Gallagher, 2006; Ockwell et al., 2008).

Moreover, the processes and mechanisms through which technological transfer mutates into technological capacity in recipient countries presents conflicting views in major economics literature (Ockwell et al., 2008). In turn, they present the ways in which knowledge is constructed and as a result, prompted commentators to focus their lens on neo-classical theories of technological transfer (Ivarsson & Alvstam, 2005; Ockwell et al., 2008; Pack & Nelson, 1999).

In this regard, capacity building in developing countries unintendedly accompanied capital investments made. That is to emphatically stress that, increasing capital investments in all levels would significantly accelerate capacity building and this could be done by providing a more competitive economic policy environment (Ockwell et al., 2008).

2.9 Incentives and Policy Instruments

It is important to stress that, the whole discussion about electric vehicles in Kenya and elsewhere is largely dependent on the financial willingness and political support from policy makers (Ramjerdi & Fearnley, 2014). In that regard, Ockwell et al. (2008) argue that, the cost and risk of such policies is a major concern for both developed and developing countries.

More generally, automotive manufacturers and businesses look forward to government to provide a clear overview of their willingness, in terms of policies and economic instruments geared towards reducing carbon emissions.

This has to be transparent and identify future transport strategy and state emphatically taxes and incentives that will be provided in promoting low carbon technologies (Ockwell et al., 2008). As Fearnley et al. (2015) argues that, incentives that are directed towards reducing the purchase price of BEVs speeds up their diffusion rate.

With regards to policy, the pivotal point is the setting and enforcement of emission standards. For example, China's ability to introduce stricter emission regulations and standards and this development, facilitated Toyota's decision to manufacture hybrid vehicles in China (Ockwell et al., 2008).

Whereas in Kenya, Environmental Management and Coordination Acts (EMCA) constitute the main law guiding pollution prevention and atmospheric pollution. Other key laws linked to air

quality control includes; Environmental Policy 2013, Air Quality Regulations 2014, Kenya Standards Act, Cap 496, Kenya Standard (KS 1515), The Occupational Safety Act 2007, Public Health Act, Cap 242, National Transport and Safety Act, 2012 and the Energy Act 2006 (Ehsani & Mwaniki, 2017).

The success of Norway in global electric vehicles transition can be attributed to the high taxation of its transportation regime. That is to say that, the high taxes in the forms of registration taxes on new vehicles, annual taxes, taxes on fuels and numerous toll roads. According to Fearnley et al. (2015), The heavily taxed transportation sector gives room to introduce incentives to annul the high taxes and hence this approach influences the sale of vehicles (Ockwell et al., 2008).

CHAPTER THREE: RESEARCH THEORY AND ANALYTICAL FRAMEWORK

3.1 Introduction

Generally, understanding socio-technical transitions could be complex. The socio-technical approach to transitions conceptualizes transport, energy and agri-food systems as a configurations of elements that include technology, policy, markets, consumer practices, infrastructure, cultural meaning and scientific knowledge (Elzen et al., 2004; Geels, 2004; Rip & Kemp, 1998; Smith et al., 2005). In other words, these elements are described as 'socio-technical' systems and radical shifts in these systems are referred to as socio-technical transitions.

Going forward, the various elements under these socio-technical systems are connected to various actor groups, (e.g. firms and industries, policy makers and politicians, consumers, civil society, engineers and researchers), who maintain, reproduce and alter system elements (Geels, 2011).

In practice, the socio-technical approach to transitions addresses co-evolution and multi-dimensional interactions between industry, technology, markets, policy, culture and civil society (Geels, 2011). Hence, understanding these wide ranging and complex transitions to new transport systems, energy, agri-food and other systems requires analytical frameworks that takes into consideration multiple approaches.

The MLP is an analytic framework that basically explores how technological and other forms of transitions are carried out. Also, the MLP seeks to explain the interaction of actors, developments and innovations. Thus, they serve as a bridge between evolutionary economies and technological studies (Geels, 2012).

Going forward, the MLP will be generally explained before being used as a heuristic device to analyze the specific case of electric vehicle transition in Nairobi-Kenya that is to say that, the transport sector or domain will be the focus of the MLP in this thesis.

3.2 The Multilevel Perspective Theory in Detail

Amongst the numerous theories and frameworks in social science, the multi-level perspective theory stands out to be unique and the complex nature of the transport industry makes the MLP suitable to be applied (Geels, 2002). As Rothaermel (2001) argues, the transport sector is represented by large firms which possess 'complementary assets' including specialized manufacturing capability, experience with large scale trials, access to distribution channels, service networks and complementary technologies.

In turn, "The multilevel perspective has emerged as a fruitful middle-range framework for analyzing socio-technical transitions to sustainability" (Geels, 2011, p. 24). The underlying concept of the framework is that regime transitions are dynamic and complex and involves the interplay between governments, industry, technology, markets, culture and society (Geels, 2012;Geels & Schot, 2007).

In detail, "the basic ontology behind the MLP stems from the sociology of technology, where three interrelated dimensions are important; (a) socio-technical systems, the tangible elements needed to fulfill societal functions; (b) social groups who maintain and refine the elements of socio-technical systems, and (c) rules (interpreted as regimes) that guide and orient activities of social groups" (Geels & Kemp, 2007, p. 442)

In addition, socio-technical transitions are carried out as non-linear process mainly because of the interplay between the three analytical levels; niches (the locus for radical innovations), socio-technical regimes (the locus of established practices and associated rules) and an exogenous socio-technical landscape (Geels, 2002; Rip & Kemp, 1998).

Geels et al adds that, "these levels refer to heterogeneous configurations of increasing stability, which can be seen as a nested hierarchy with regimes embedded within landscapes, and niches existing inside or outside regimes" (Geels, 2011, p. 52). Niches constitute 'protected spaces' such as research and development laboratories, subsidized demonstration projects or small market niches where users have special demands and are inclined to extending support to emerging innovations (See Figure 3.1). In that regard, niche actors work on radical innovations that deviate from existing regimes (Geels et al., 2011).

Generally, niche actors hope that their promising novelties or innovations penetrate into the regime or even replace it. However, this is difficult, due to the many lock-in mechanisms that stabilizes existing regimes. Nonetheless, niches provide seeds for systemic change and hence they remain a crucial component in transitions (Geels et al., 2011).

In transitions, novelties compete with technologies that benefit from well-developed systems around them. Thus far, the alignment of existing technologies, regulations, user patterns, infrastructures and cultural discourses results in socio-technical systems (Geels, 2004). However, Geels et al (2011) argues that, the actors of system element do not act in vacuum but rather embedded in socio-technical regimes.

According to Geels (2011), the regime level is the most crucial level within the MLP since the underlying concept of socio-technical transitions is a shift from one regime to the other, and niche

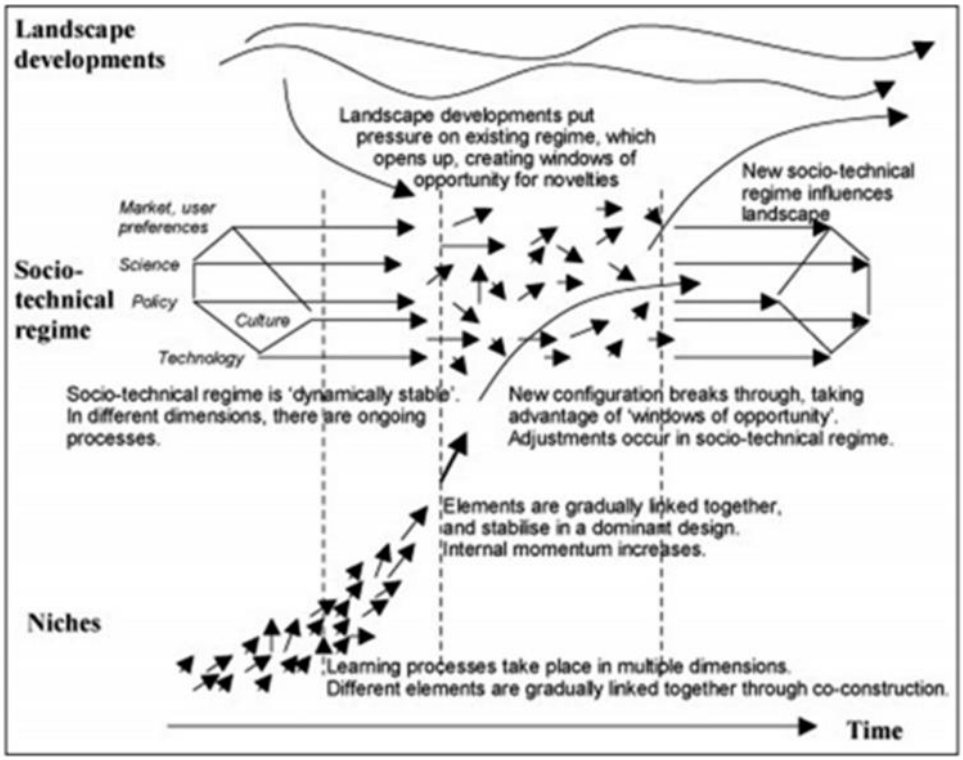
and landscape levels are considered as “derived concepts” in relation to the regime. They involve processes that differ from current regime and the surroundings that affect the interaction between niches and regime.

Sequentially, it is the stability or instability of regimes that creates either “lock ins” or “windows of opportunities” for niches to be established (Grin et al., 2010), and in turn, the coetaneous synergy of the three independent levels (socio-technical landscape, socio-technical regime and niche) of the MLP takes into account the strength and weaknesses of both actors and networks and facilitate technical transitions whilst adopting instability, stability, acceptance and opportunities (Geels & Kemp, 2007).

The niche level is regarded as the least stable level amongst all the three levels represented in the MLP. Within it, rules constantly change, and alliances or partnerships could be formed or dissolved at the same time. Also, social networks are needed to nurture novelties, whereas rooms are needed to facilitate learning processes that allows for improved performance (Grin et al., 2010).

Below, is the representation of the MLP, showing the three analytical and heuristic levels, which will be discussed independently in the next section.

Figure 3. 1: The MLP Framework



Source: (Geels, 2002, p. 1263)

3.3 The Socio-technical Landscape

The socio-technical landscape is a vast extrinsic layer of the MLP that exists and informs the societal narrative which is largely shared and sustained (Grin et al., 2010). In other terms, the socio-technical landscape constitutes the wider element within the multi-level perspective framework. It operates more independently, as compared to the socio-technical regime and niche.

This vast extrinsic layer or level is hard to reach to actors as well as the ideas in regime and niche levels. As a result, there exists a long-term and a bleak opportunity to initiate change (Geels & Schot, 2007).Rip & Kemp adds that, "the socio-technical landscape is a landscape in the literal

sense, something around us that we can travel through, and in a metaphorical sense, something that we are part of, that sustains us (Rip & Kemp, 1998, p. 334).

Within the framework, the landscape provides the setting that facilitates regime and niche development. The socio-technical landscape "highlights not only the technical and material backdrop that sustains society, but also includes demographical trends, political ideologies, societal values and macroeconomic patterns" (Geels, 2011, p. 28).

They emphasize on the forces at work that suppresses regime and niche levels, however, these forces cannot be said to be a part of niche and regime levels. "landscape developments comprises of both slow-changing trends (e.g. demographics, ideology, spatial structures, geopolitics) and exogenous shocks (e.g. wars, economic crises, major accidents, political upheavals)" (Geels, 2018, p. 225).

In practical terms, landscape events combine in a landscape shock that triggers regime changes and forcefully opens up window of opportunity (Van Bree et al., 2010; Verbong & Geels, 2010).

The landscape consists of three crucial factors that characterizes change. In the early stages, change is often slow and hardly recognizable. Secondly, there are long term shifts and then external shocks that triggers changes (Grin et al., 2010). An example is the oil crisis of the 70's which resulted in significant changes in energy systems globally.

In the case of Electric vehicles for example, Berkeley et al. (2017) notes that, several landscape factors interplay and create the environment needed to facilitate electric vehicle transition; global policy drivers such as environmental, energy security as well as national policy drivers pushing battery electric vehicles research and development, infrastructure and incentivizing consumer take up that is driven by technology.

Clearly, changes within socio-technical landscape sets the momentum for radical innovations. In detail, the pressure exerted creates "windows of opportunities" that opens for radical innovations to sail through and find feet within existing regimes. However, considering niches, timing is very crucial at this phase as windows of opportunities could easily much faster than expected, thus when there is landscape pressure preparing ground for change while new technology is not completely developed (Geels, 2002).

Theoretically, these drivers create the conditions that facilitates socio-technical transitions, but in practice, different policy goals, directives, priorities, visions and incentives of different governments and regions may cause a deviation from the expected trajectory (Nykvist & Måns, 2015).

3.4 Socio-technical Regime

The socio-technical regime forms the "deep structure" that accounts for the stability of an existing socio-technical system (Geels, 2004). The extent of alignment or tension across several rules and whether actors respect rules or not determines the stability of regimes (Geels, 2005). Examples of these regime rules include cognitive routines and shared beliefs, capabilities and competences, lifestyles and user practices, favorable institutional arrangements and regulations and legally binding contracts (Geels et al., 2011).

Geels adds that, the socio-technical regime "refers to the semi-coherent set of rules that orient and coordinate the activities of social groups that reproduce the various elements of socio-technical systems" (Geels, 2011, p. 27), and it aims to highlight the meta-coordination between the different sub-regimes (Geels, 2004).

Additionally, Geels (2011) argues that, within the socio-technical regime, innovations occurs gradually, with small adjustments accumulating into stable trajectories, and this is mainly because existing regimes are characterized by lock-ins.

According to Geels (2004), the socio-technical regime encompass not only firms and the activities of engineers but also other social groups, such as users, policy makers, special interest groups and civil society actors. This concept thus helps overcome the tendency, which is prominent in innovation studies, where, manufacturers are considered as the prime regime actors.

In that regard, Geels et al. (2011) notes that, although car manufacturers forms an integral part of the regime (who exert much influence through their product offerings, marketing strategies and political lobbying), other elements such as habit of use, prevailing normality and mindsets and established practices of professionals, such as transport planners, also sustains the regime.

On the other hand, incumbents within the regime may want their interest to be protected and therefore push agendas that would maintain and prolong their existence. As a result, they may act as barriers to radical innovations that intimidates existing regimes. For these incumbents to take on new forms, there must first be "a breakthrough of the new technology, wide diffusion and competition with the established regime" (Geels, 2005).

3.5 Niches

Contrary to the regime level, is the niche. They are often referred to as "locus of radical innovations" (Geels, 2014, p. 23). They are the micro-level where radical novelties appear. However, these novelties at the initial stages are characterized by an unstable sociotechnical configuration as well as low performance (Geels & Schot, 2007), where niches are also referred to

as seedbeds (Mazur et al., 2015), or incubation rooms, thus protecting or shielding novelties against mainstream market selection (Geels, 2002;Geels & Schot, 2007).

In practice, "niche-innovations are important because they are the seeds of transitions" (Grin et al., 2010, p. 24). These seeds grow with time as they "build up internal momentum, through learning processes, price performance improvements, and support from powerful groups" (Geels & Schot, 2007, p. 400).

These niche-level innovations are designed by small networks of dedicated actors who may be key players or outsiders (Berkeley et al., 2017). These niche actors work on radical innovations that may be completely different from existing regimes. However, these radical innovations are willing to take chances and penetrate through existing regimes (Geels, 2002). In Kenya, Nopea Ride and Opibus constitute the niche actors in the (EV) automobile industry, and they will be looked more into in chapter 5.

Inspiringly, the goal of niche actors is that their innovations find ways into regimes and being adopted completely and possibly becoming the dominant regime with time. However, with limited rules and dynamic nature of regimes generally, actors are faced with uncertainties as to how innovations may perform (Geels, 2002).

When innovations being designed shows no correlation with existing regime orientation, it becomes difficult for actors to identify niches. Although, there is competition amongst niches with the regime, this is not entirely true in all scenarios, as they may be absorbed naturally by regimes and trigger changes afterwards. Niche resource availability is paramount in determining the speed of change in innovation (Geels, 2002).

Moreover, niches provide the space needed to facilitate and groom social networks that support innovations, and they include lobby groups, user associations and new industry networks (Geels, 2005). The roll out of events within landscape and regime levels are crucial and influences the success of innovations (Geels, 2002).

The MLP is coupled with a number of criticisms some of which include the fact that, it has neglected place and space (Smith et al., 2010), and underplayed the role of agencies in transitions (Geels, 2011).

Thus far, it is possible that cities and regions may accelerate sustainability transitions and hence provide the resources and materials for a successful innovation process (Truffer & Coenen, 2012), and niches can emerge at both regional and national scales (Coenen et al., 2010).

CHAPTER FOUR: RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

In general terms, a research design represents a course of action that a researcher undertook to get from here to there. In principle, the moment when the researcher formulates his research questions constitutes the "here". Whereas, the moment he finds answers to the research questions he formulated and make conclusions on the dilemma constitutes the "there" (Yin, 2014).

The scientific viewpoint of a phenomenon affects the ontological status of research data as well as the understanding and interpretation of data. Therefore, the most important precaution with the choice of a particular methodological course, is for the researcher to ensure that, there is a match between the research approach taken and the requirements of the research questions he has put forward (Blaikie, 2010).

With regards to this thesis, I have relied significantly on explorative research design principles, I find it coherent with the research problem I have decided to explore. In that sense, Bryman (2016) argues that, the priority given to dimensions in the research is emphasized by the research design chosen. And in most cases, these decisions comprises of what needs to be studied, why is to be studied and how is it going to be studied (Blaikie, 2010).

In this thesis, my focus is understanding the possibilities for an electric vehicle transition in Kenya. This topic has been studied broadly in most developed countries using the MLP framework, however, less has been done in applying the framework in developing countries context.

In collecting data for this thesis, I engaged with key stakeholders within the transportation sector in Kenya in order to generate effective responses. This will be explained in much detail in this chapter.

4.2 Research Questions

Consequently, three research questions are formulated as follows:

1. What are the main barriers/challenges for an EV transition in Kenya?
2. What could speed up EV transition in Kenya?
3. Is the political, environmental, economic, cultural and social climate favorable for a faster EV transition in Kenya?

4.3 Research Strategy

In order to find the needed answers to the research problem and questions I have put forward, I decided to rely on abductive research strategy. One could argue that the focus of this thesis is aimed primarily at assessing the possibilities of an electric vehicle transition in Nairobi-Kenya.

According to Danermark et al. (1997), abductive research strategy is a logic of investigation that seeks to interpret and re-contextualize social phenomena within the frameworks of a given social structure or pattern. He argues that, the established theoretical lenses through which phenomena are analysed presents the researcher an opportunity to consider new perspectives.

Most importantly, I chose to rely on Danemark's definition or concept of abductive research strategy due to two important factors.

To begin with, the research methodology adopted in this study is the explorative research. Although, the underlying concept of the explorative research strategy is to clarify the exact nature of a phenomenon, Hellevik (1995) notes that, when a researcher is confronted with a research problem that is significantly ambiguous, and complex and have little knowledge of the topic he is confronted with, then the abductive research strategy is the best fit. Although I have read a considerable volume of literature on socio-technical transitions, the existing literature has focused

intensely on the developed nations, and hence I find myself in a limited information or knowledge position, regarding the concept when applied in developing countries.

Secondly, relates to the qualitative nature of the research enquiry. This is very important in this study since I intend to make a stance concerning the study. As Blaikie (2010) put forward, it is important for the researcher to take a stance between the research and the researched, and more importantly, whether he will be a detached observer, who by all standards is distant from the phenomenon but produces reliable data or mediator of languages taking into consideration lay account and technical account, and studies phenomena by giving it meaning through interpretation.

Hence, the abductive research strategy thus allows such an in-depth qualitative research study to be carried out.

4.4 Research Design

Generally, quantitative and qualitative research methods constitute the two main approaches for data collection and analysis, reduction, ethical considerations as well as final findings in the research process (Creswell, 2014; Punch, 2013; Silverman, 2013).

Qualitative approach is "one in which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e. the multiple meanings of individual experiences, meanings socially and historically constructed, with an intent of developing a theory or pattern) or advocacy/participatory perspectives (i.e. political, issue oriented, collaborative, or change oriented) or both"(Creswell, 2014, p. 18).

Contrastingly, quantitative research method is centered on quantifiable measurement processes and the quantification of statistical aspect of social interaction, while qualitative is premised on

empirical aspects of social life, that are descriptive, subjective and difficult to measure, and meaning and interpretation provided by social actors is crucial (Blaikie, 2010).

In this thesis research process, I have applied qualitative research method which takes into consideration the ontological interpretative assumption which asserts on the belief that, "the real world, and the phenomena and events that occur in this world, are created by the subjective thoughts, actions and interactions of people who inhabit it" (Brotherton, 2008, p. 36).

Hence, applying qualitative research method in this thesis is crucial for addressing the research questions I have put forward. The detailed explanation of the approach is explained in the next section.

4.5 Qualitative Research Approach

In this thesis, I have applied qualitative exploratory research method. Although, the underlying concept of this method is to investigate a problem that has not been studied thoroughly, Neuman adds that, exploratory research is "premised on the purpose to examine a little understood issue or phenomena and to develop preliminary ideas about it and move towards refined questions" (Neuman, 2014, p. 38). The concept of electric vehicle transition in developing countries using the MLP is less explored in several academic literature, including Geels et al. (2011)"*Automobility in Transition-A socio-technical Analysis of Sustainable Transport*" and Figenbaum (2017) "*perspectives on Norway's supercharged electric vehicles policy*" amongst others.

In detail, explanatory research addresses the 'what' research questions (Neuman, 2014; Yin, 2003), and this thesis framing of 'what' research questions are 'what are the main barriers/challenges for an electric vehicle transition' and 'what could speed up electric vehicle transition in Kenya'.

Going forward, qualitative research approach differs significantly from quantitative research approach, in terms of the of the approach used in collecting and analyzing data, however, both qualitative and quantitative research methods are subject to criticisms (Silverman, 2013).

According to Blaikie (2010), the basic premise in qualitative study is the technical language used by the researcher, where data is produced and reproduced by both the researcher and social actors. In detail, Blaikie adds that, "languages are used to describe behaviors, social relationships, social processes, social institutions and in particular the meanings people give to their activities, the activities of others, and to objects and social contexts" (Blaikie, 2010, p. 204).

Undoubtedly, the use of qualitative approach or data collection methods in this thesis is crucial, in that, it offers in-depth empirical data on electric vehicle transition in Kenya with the use of the MLP framework as well as guarantee high logical probability, credibility, validity and liability of the social phenomenon (Lincoln & Guba, 1985; Neuman, 2014).

4.6 Data Collection

It is very important to understand that, social phenomena could be approached considering both the scope and meaning (Wadel & Wadel, 2007). In gathering the required data for this study, I will rely on qualitative methods. This is because they allow the collection of non-numerical data.

In turn, a thorough process of analyzing the instruments and tools for collecting empirical data through interviews, document review, and use of newspaper articles, blogs, parliamentary white papers and online sources on the phenomenon were utilized.

More importantly, the use of interviews, as a data collection technique was key to this thesis, and presented a major source of primary data for this thesis. Therefore, based on an interview guide, semi-structured interviews were conducted, which took into consideration the three analytical

levels of the MLP, that is niches, regime and socio-technical landscape, as well as other important questions related to the phenomenon.

In turn, this study has fused different methods through triangulation and hence allowed me to repress inherent bias that often comes into play when a single method is applied (Ellefsen, 1998).

The overall sample size in this study was nine in total, which included CEO of Nopea Ride, two senior executive members of Opibus, one official from Ministry of Energy-Kenya, one official from UNEP-Kenya, one official from Kenya Revenue Authority, Project Officer for Transport Climate Strategies (GIZ), one car importer, and one local resident.

In total, seven (7) semi-structured and two (2) unstructured interviews were conducted, and data collection for the interview was collected via the notes collected from the skype interviews that were conducted. Below, is a table showing interview respondents and their respective positions/titles.

Table 4. 1: Presentation of Interview Respondents

Interview Respondents	Position/Title	Given Identity of Respondents.
Juha Suojanen	CEO, Nopea Ride	R1
Mikael Gange	Founder & CSO, Opibus	R2
Filip Gardler	Founder & CEO, Opibus	R3
Fred Mwathani	Official, Ministry of Energy, Kenya	R4

Alexander Koerner	Program Officer, UN Environment Electric Mobility Programme	R5
Humphrey Mpasa	Executive Official, Kenya Revenue Authority	R6
Herman Kwoba	Project Officer, Transport Climate Strategies (GIZ)	R7
Seth Nkoro	Vehicle Importer	R8
Lucey Shinez	Local Resident	R9

4.7 Ethics Committee

For the purpose of this study, the researcher has obtained an ethical clearance from the Ethics Committee. The researcher will therefore seek the consent of all relevant parties, thus including permission from all respondents, interviewees before engaging them. Secondly, the researcher has assured all these parties of confidentiality of information and data collected. Finally, the researcher has duly acknowledged all existing literature, documents and other foreign materials that were used to avoid plagiarism.

4.8 Conducting the Interviews

The basic understanding of an interview is a one-on-one conversation between an interviewer and an interviewee. However, in social science research, Punch adds that "the interview is one of the main data collection tools in qualitative research. It is a good way of assessing people's perceptions, meanings and definitions of situations and construction of reality" (Punch, 1998, p.

174). As mentioned earlier, the interviews conducted in this thesis, was guided by the NSD requirements.

Moreover, several approaches are used in conducting interviews, that is structured interviews, group interviews, focus group and unstructured interviews mainly via face to face and technological tools via telephone and videoconferencing (Brotherton, 2008; Punch, 1998).

This study made use of both semi-structured and unstructured interviews, which to a larger extent, allowed me to ask more open ended questions, thus, allowing for a discussion with interview respondents.

Going forward, these interview protocols were observed during the interview process. Firstly, the researcher thanked the respondents for their time and effort in participating in the interview. Secondly, the theme, a brief introduction of the research, and the aims and objectives was presented to the respondents to give understanding of the topic and the significance of their involvement in the study. Thirdly, the respondents were made to understand that, the research was mainly for academic purpose and so confidentiality, and protection of personal data would not be compromised. Lastly, the researcher asked permission to take notes from the interview discussion to ensure quality and clarity of the responses given, and assured respondents that all information collected will be discarded after the research delivery.

4.9 Data Analysis

In social science research, it is crucial that the researcher systematically applies statistical or logical techniques to evaluate the data collected. The preamble for data analysis for this thesis was based on the primary data collected from interview respondents, represented as R1, R2, … & R9.

This thesis, therefore, identifies with discourse analysis as a logical technique in evaluating the data collected. According to Jankowicz (2005), discourse analysis is very crucial when listening or trying to understand people's narrative of a particular development, and more importantly the technique allows for a more multidisciplinary perspective in understanding a phenomena (Grant et al., 2005).

Although discourse analysis can be applied in several fields, the technique is mostly applied in interviews, mainly semi-structured, as applied in this thesis and other studies, including research on consumers shopping experiences (Sitz, 2008) and a case study of new-start entrepreneurs in New Zealand (Mills & Pawson, 2006).

4.9.1 Identifying the Thematic Framework

In classifying and organizing the data for this study, the thematic framework was applied. As argued by Ritchie et al, the thematic framework is crucial to classify and organize and organize data according to key themes, concepts, as well as emergent categories (Ritchie et al., 2003). The theoretical background in Chapter 3 (Research Theory and Analytical Framework) provided a background for capturing the key themes and concepts to analyze the data thematically.

In that sense, the thesis deduced the key themes and concepts from the theoretical framework and paired them with the primary data collected from the interviews and analyzed.

4.9.2 Significance of the Study

The study to assess electric vehicle transition in Kenya is highly important and timely because:

1. Academically, it will contribute to the existing literature on electric vehicle transitions and significantly contribute to addressing the literature gap of electric vehicle transition in developing countries.

2. In policy making, this study will be beneficial to Ministries and Government Agencies, as they make and implement policies and strategies regarding zero carbon transportation, climate change and sustainability discourses.
3. The findings of this study will form a basis for further researchers who might be interested an advancing this study in other parts of the world.
4. Contribute to the MLP literature by applying the framework to a developing country context.

4.9.3 Limitations of the Study

It is important to know that, conducting scientific research comes with a number of challenges in diverse forms. In detail, the use of qualitative research method in this study, clearly shows that validity cannot be ruled out as a key limitation to this study.

In simple terms, validity of a research highlights on the accuracy of a measure. However, Silverman adds that validity in a study can be compromised and lead to biasness on the part of the researcher, in the event where the researcher attempts to incorporate conflicting views on the phenomena to the study (Silverman, 2013).

Additionally, reliability also constitute a key limitation in qualitative research approach. Although, the concept of reliability highlights on the consistency of a measure, that is if the same results can be achieved by applying the same technique, method and circumstances, Hammersley defines reliability as, “the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions” (Hammersley, 1992, p. 67).

Also, due to the small sample size, generalizability of the findings as well as quality of this research will be difficult to be deduced in this study (Yin, 2003). Consequently, purposive selection or

sampling of interview respondents increases biasness of the study and hence has the potential to alter the validity of findings of the research (Creswell, 2014; Silverman, 2013).

Moreover, the COVID-19 pandemic, also known as the corona virus pandemic, which is an ongoing global pandemic, which broke out early 2020 till date, and brought about travel restrictions globally, made it impossible to travel to Kenya, to actually have a deeper understanding of the development, and hence had to rely on information, documents and data provided by interviewees and online databases.

CHAPTER FIVE: APPLYING THE THEORETICAL FRAMEWORK (MLP)

5.1 Case Study of Nairobi-Kenya

In this chapter, I will be applying the MLP in the Kenyan context based on interviews with key stakeholders (interview respondents) as well as other existing literature. In detail I will be describing the socio-technical landscape, sociotechnical regime and niche innovations in the context of Kenya.

5.2. Socio-technical landscape

The socio-technical landscape emphasizes on the independent forces which influences regime and niche levels within the MLP, and triggers changes in society. As said earlier, these independent forces include oil shocks, environmental concerns (climate change), economic crisis as well as pandemics. For example, the oil crisis of 1973 triggered the sudden transition towards renewable energy in Denmark, and in turn have led to Denmark's heavy reliance on renewable energy sources currently.

The electric vehicle transition in the developed world has been driven significantly by climate change and the need to reduce global average temperature. Conversely, the high cost of crude oil products in Kenya has been the dominating factor in the transition towards electric vehicles, although climate change and environmental concerns such as air pollution within the city of Nairobi are a major concern as well.

In detail, these changes within the socio-technical landscape set the momentum for radical innovations and created windows of opportunities for electric vehicles to sail through. Currently, Nopea Ride and Opibus has collectively produced 47 EV's in Kenya, with the former producing

40 Nissan leaf vehicles, which is been used as commercial taxis in Nairobi and the latter converting 7 ICE vehicles to EV's which is been used in the safaris and national parks in Kenya.

5.3 Socio-technical Regime

In general, Kenya has a very low vehicle ownership rights as compared to countries within the global north, thus developed countries. In terms of private vehicles, According to Interview Respondent 7, (Represented as R7), Kenya has about a 50-100 vehicles maximum per 1000 capita, whereby most developed countries have about 600 vehicles per 1000 capita. This means that, vehicle fleet in Kenya, on the global scale, still remains low.

However, vehicle fleet within the region is growing rapidly as income levels are increasing and the global economy is expanding. In this regard, vehicle fleet within the region is expected to increase significantly in the coming years.

On the other side, Kenya has a very poor public transport system, and Nairobi in particular, has no formalized transport system, based on fixed fare prices and scheduled services. Although, this system is not perfectly designed, it operates quiet well and serves as the major means of transport for the larger population. He adds that, "this means of transport is the backbone of Kenya's transportation system" (Interview Respondent 7).

As Geels (2004) argues, incumbents are regime rulers and reproduces the socio-technical elements of an energy system. Interview Respondents R1, R8 and R9 adds that, The incumbents within this region consists of ICE operators, users, vehicle importers, and the public transport services offered by UBER, mini and long buses (matatus) as well as train services that are involved in the transport of people, goods and providing other services as well. There is also the "circles" which implies the collective group or association that owns and operates public transport in specific regions. These

"circles" have a big pool of vehicles, consisting of several private individuals and they are supported by micro-finance institutions, which helps members finance new and maintain old vehicles (See Figure 5.1).

Incumbent's reaction to accelerate the transition towards greener and sustainable transport systems is critical to mitigate greenhouse effects and this could be looked at from both a technical and financial perspective. Technically, environmental quality could be improved by eliminating lead additive from gasoline. However, caution must be exercised to ensure that, other octane enhancers with potential health impacts do not replace lead (Gwilliam, 2003), whereas, in financial terms, incumbent acceleration towards transition could be achieved by adopting policy incentives (Jenn et al., 2018; Leibowicz, 2018). In China for example, several industry policy programs were introduced by the government to facilitate the production and purchase of electric vehicles (Välikangas, 2018).

The public transport system is very crucial in the regime level. Interview Respondents R2, R4 and R7 adds that, the high vehicular traffic in Nairobi and surrounding cities also makes motor cycles and bikes popular, although there is poor infrastructure for them. However, this system is one way or the other similar to systems in Europe and North America, as there are significant logistics, Business to Business services, and delivery services within the region.

With high prices of crude oil products being the greater force exerting pressure on the regime, and high pollution levels within Nairobi, and climate factors being supporting forces leading to an alternative in mobility, Kenya's transportation regime is set to experience significant change in the coming years. Regime actors and players in Kenya embrace new technologies and market trends and they are more fascinated about the fact that, electric vehicles could save them up to 80% of their income, and hence that is regarded as the biggest driving factor. Interview Respondent R9,

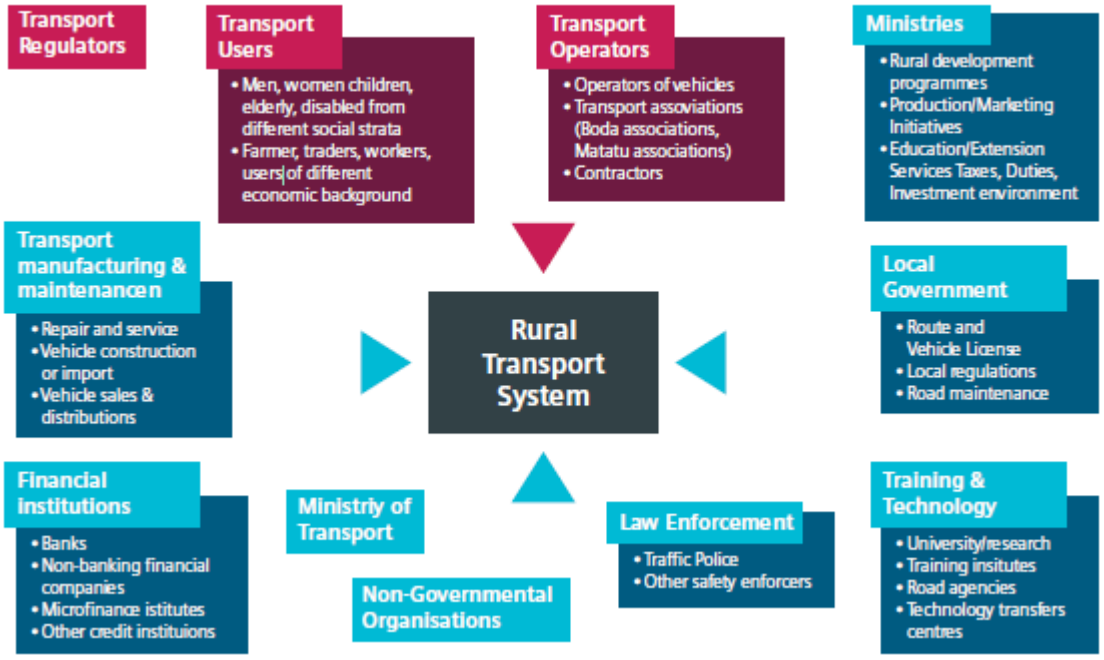
adds that "I will always opt for cheaper transport options, the availability of EV taxis (Nopea Ride) in Nairobi has made me saved a substantial amount of money I spend on transport monthly".

Clearly, there is changing shared beliefs amongst groups ruling the regime and this is expected to have a significant effect on the regime with time. According to Interview Respondents R1, R2, and R3, quiet a significant number of people within the city have confronted their companies and have shown much interest in EV's. Interview Respondent R3 adds that "the major challenge on the side of these consumers/potential buyers is how to meet the financial requirements or capital to purchase our product (EV)".

The issue of resistance from regime actors and players is also crucial to electric vehicle transition. In the case of Kenya, niche actors have taken into the consideration the concerns and actions of these incumbent and regime actors. It has therefore, organized a number of conferences and other programs to introduce the technology to these actors. These includes, The Africa Sustainable Transport Forum Ministerial and Experts Conference on 28th to 30th October 2014 at the UN Headquarters in Nairobi-Kenya, the World Energy Day Conference organized in October 2018, distinguished lecture on Renewable Energy Solutions by Dr. Ioannis Tsipouridis, organized in November 2019 and most recently, Renewable Energy E-mobility Conference East Africa organized in February 2020 at Crown Plaza Hotel, Nairobi-Kenya (Interview Respondents R1, R2, R3, R5 and R7).

In the process, regime actors and incumbents have been convinced about the prospects of the technology and the need to see it as an alternative stream of income. The strategy of niche actors have not been to put up competitive markets in the early stages of the transition and in turn this has approach has worked out perfectly and hence resulted in almost no resistance from incumbents, which is a good atmosphere for a faster transition.

Figure 5. 1: Incumbent/Regime Actors & stakeholders in Kenya's Transportation Landscape



Source; (SIEMENS Stiftung, 2020, p. 8)

5.4 Niches

External factors such as crude oil prices, climate change and environmental concerns remains key factors that allowed for novelties to emerge in Kenya's transportation landscape. In reality, these external factors pushed for electric vehicles into the transportation landscape. In the past three-four years, electric vehicles market in Kenya have been regulated by Nopea Ride and Opibus. Although, electric vehicles could save up to 80% of operational cost to users, a significant portion of ICE users is challenged with range anxiety and inadequate charging infrastructure, considering the high vehicular traffic in Nairobi and surrounding cities.

The transition in Kenya is unique, in the sense that, the key companies, Nopea Ride and Opibus has different operational strategies. The former (Nopea Ride) imports used electric vehicles and runs them as commercial taxis within Nairobi, whereas the latter, converts already existing ICE vehicles into electric for use.

Currently, Nopea Ride, has about 40 electric Nissan leaf vehicles in operation within Nairobi, and has installed charging points in popular malls within the city. On the other hand, Opibus, has successfully converted seven ICE vehicles to EV's for use in the safaris and national parks within Kenya, and it plans to roll out a massive conversion of public buses (matatus) starting this year (2020).

Interview Respondent R1, R2 and R3 argues that, what their companies (Nopea Ride and Opibus) identify as opportunities for electric vehicles to penetrate into the Kenyan market, is the fact that there is high demand for taxi hauling services, where people sign up for taxi services with taxify, uber and etc at somewhat high prices, as compared to the service charge associated with electric vehicles taxi services (Nopea Ride).

In addition, the availability of "Empessa" which is a digital payment system, which has been the dominant electronic payment system in Kenya is crucial to niche actors. In this regard, EV niches sees the ability to use this platform in the near future for payment of electric vehicle charging. In that sense, operators could be allowed to participate in the same system. As compared to parts of Europe, where there have been scattered market charging systems (Interview Respondents R1, R2 and R3).

Also, vehicle owners in Kenya, have the opportunity to charge their cars in their homes, because is not densely populated as cities within Europe, where cars usually pile up by the road. The region has a very efficient power grid and energy infrastructure in general as compared to other developing countries. Rural electrification in the region has been improved over the years as well, and therefore creates the room for charging for rural residents.

With Nairobi, and the bigger cities, Even though, there are about once or twice power cuts, the grid has been fairly stable and it has one of the best energy mix within East Africa, with about 80% of its energy being renewable. This is as a result of electrification programs introduced by the Kenyan government, including the 'Energy Access Scale-Up Programme' which targeted 70% of electricity access by 2016 and 100% by 2020 (Energy Regulatory Commission, 2011, 2013; Republic of Kenya, 2011) and the 'Last Mile Connectivity Project' which provided grid electricity to a large share of the rural population (Safety Health & Environment Department, 2014).

Comparing Kenyan power to German power for example, I argue that Kenyan power has a much lower carbon footprint, and so in terms of greenhouse gas emissions benefits, this would be much larger in Kenya due to the cleaner grid. In practice, the current energy output of Kenya is fairly good and therefore capable of speeding up EV transition in the region.

5.5 General Discussion

This section discusses the application of MLP in electric vehicles transition in Kenya, and other crucial subjects linked with the transition.

In most developed regions within North America, Europe and parts of Asia, climate change and providing sustainable transport solutions has been a dominant factor for electric vehicles transition. However, it is the inverse in developing countries, as electric vehicles transition has been dominated by the increasing cost of crude oil. Although climate change concerns, air and noise pollution are crucial, these factors remain minor landscape factors with regards to EV transition in Nairobi-Kenya.

The application of the MLP in electric vehicles transition also reveals the dynamism of transitions in general. To begin with, the landscape factors or forces exerting pressure on regimes and giving rise to new technologies has been high crude prices followed by environmental concerns.

In the case of Kenya and other developing countries in general, most fleet vehicles are usually imported vehicles and so there is obviously a huge market for second used vehicles and this in turn contributes to having vehicles that are outworn and inefficient on the streets.

According to Trading Economics (2020), gasoline prices in Kenya increased to 0.85 USD/Liter from 0.79 USD/Liter in May of 2020. In turn, ICE users are burdened with high operational cost, arising from fluctuations in crude oil prices and high maintenance cost of ICE vehicles. Though, EVs are comparatively expensive on initial purchase, mainly because of the high cost of batteries, they are cheaper to run in the long term because they present minimal maintenance and running cost to the user.

Secondly, environmental concerns have been a key factor. The large presence of used imported vehicles in the region, is a major challenge. The emissions from these vehicles are significant and results in poor air quality and noise pollution in Nairobi. In detail, air pollution, generated by fuel combustion has been linked to a wide range of health effects, including more than 800,000 deaths in cities around the world (Ezzati et al., 2004; Pope III & Dockery, 2006), and about 18,000 deaths in Nairobi, Kenya (World Health Organization, 2018). Hence the introduction of electric vehicles in this region would go a long way to benefit a lot of stakeholders.

Generally, the current regime actors, thus ICE users, and Kenyans in general embrace new technologies (Interview Respondents R1, R2, R3, & R9). However, electric vehicle has not received the needed government support in this region, although policymakers remains committed to introducing new strategies and policies to support electric vehicles transition. The pace in rolling out these policies and strategies has been slow.

As part of the study, I realized that electric vehicles publicity has not been enough, this is due to the fact, a significant proportion of regime actors and the general public actually know nothing or less about how electric vehicles function. Increasing publicity would be crucial in changing the perceptions of regime actors and the general public which would also contribute to the success of electric vehicles

5.5.1 Government Support and Commitment So Far

In the past few years, there was obviously no discussion about electric vehicles in Kenya. However, with the introduction of Opibus and Nopea Ride (EV niches) into the transportation landscape, and support from Ministries and agencies such as the UNEP, and other NGO's there have been some changes in this regard. Thus far, government has expressed much interest in electric vehicle mobility in the region.

The argument of lowering fuel importation is very crucial to governments, and that off course constitute a medium or long-term strategy. However, it needs to start on smaller scale and then expanded with time. Also the idea of becoming energy independent and getting rid of the volatile crude oil market is an interesting topic amongst mainstream policy makers in Kenya. Yet, the challenge has been with initiating the needed policies and rules to support the development.

To begin with, the government has reduced excise duty on electric vehicles. In that regard, the finance bill of 2019 proposed a reduction on excise duty for all vehicles with only electric motor for propulsion (BEVs) from 20% to 10% (The National Treasury and Planning, 2019). This has been the first step taken by the government, and EV niches (Opibus and Nopea Ride) have regarded this development as a crucial step taken by the government.

Also, the government of Kenya, through Kenya Revenue Authority (KRA) Customs has invited EV niches to join the Green Channel Program. The program, allows for a faster, cheaper and efficient cargo clearance process. In detail, the program makes it easier for companies and private persons to import renewable goods/products in Kenya. In the case of EV niches, the program allows EV parts to have reduced importation duty, and in the long run, ensures that EVs are sold at affordable prices (Kenya Revenue Authority, 2020).

There is also an ongoing dialogue between these industries and the government to introduce local production and assembly points in the country, where electric vehicles would be assembled in Kenya. In this case, EV niches will be given the needed certification from governments to become EV assemblers, manufactures and distributors within the country, where they can actually receive huge benefits from governments, whilst creating job opportunities for the citizens (IndustriAll, 2018).

With regards to job creation, The European Association of Electrical Contractors adds that, more than twice as many jobs are created in the electricity value chain as compared to job lost in automotive manufacturing. In turn, about one million high quality, local, green and permanent jobs could be created globally in fields such as electricity generation, civil and road works, battery cell manufacturing, installation and maintenance (The European Association of Electrical Contractors, 2018).

The Kenya Energy Regulatory Commission, United Nations Environment Programme (UNEP), Kenya Bureau of Standards, are currently working on strategies and policies regarding type, quality, safety and general standardization of electric vehicles to be imported and used in Kenya. Presently, The Kenya Bureau of Standards has developed and adopted standards that apply to electric vehicles imported into Kenya. Up until now, a total of 24 standards have been developed and adopted, which covers specifications and testing procedures for safety aspects as well as performance and power consumption elements (The East African, 2017).

Moreover, the government of Kenya has also stressed the need for cooperation between the federal government, the private sector and other NGOs in accelerating EV growth and development. This has resulted in cooperation between the State Department of Transport and GIZ, and this cooperation is geared towards creating the necessary policy environment and regulatory framework for the uptake of e-mobility as well as developing awareness materials on the feasibility and advantages of e-mobility in the country (State Department of Transport, 2019).

With these support and commitment so far, EV niche actors are optimistic about the future of electric vehicles in Kenya, and hence sees the government as willing and supportive.

5.6 What Factors Will Drive A Faster Electric Vehicle Transition in Kenya

5.6.1 Capacity Building and Creating Awareness for Electric Vehicle Mobility

In the global South, taking Kenya into consideration, awareness level on EV mobility has been low. A significant proportion of mainstream policy makers, stakeholders and the general public have little knowledge about electric vehicles mobility. Generally, there is skepticism with regards to durability and range anxiety of electric vehicles (Interview Respondent R1, R2 &R3).

In that regard, the issue of awareness creation has to be addressed, so that these people become informed about the opportunities and challenges with electric vehicles mobility.

Also it is necessary to implement EV demonstration projects whereby, two or three electric buses would be introduced into the public transportation landscape or bus fleet. This is very crucial as it allows the actual users to have experience with electric vehicles and what might be more profitable for them in switching to electric vehicles other than maintaining their conventional ICEs.

With Capacity Building, there has to be a long term policy, which brings on board all stakeholders together in a form of a coalition and a coordinating body in government, basically an institution in government to champion electric vehicle mobility development. In addition, there is also the need to improve on capacity building in electric vehicle technology. Obviously, the technology is new and complex, and therefore it is crucial to train local labor with the needed skill to have good control over the technology and be able to fix them, when they break down. In doing this, jobs are created in local communities and standard of living is improved in the long run.

5.6.2 Preparing the Policy Framework to Regulate Electric Vehicles

For a faster electric vehicle transition in Kenya, a much stronger and vibrant political will be needed. In the case of Kenya, there has to be a willing government that will be persuaded to create

the needed business landscape for electric vehicles that addresses the needs of EV niches as well incentives for private individuals.

In detail, government should be interested in making priority electric vehicle mobility and speeding up the initiation of policies that supports electric vehicle industry. The policy should be geared towards changing fiscal regimes, reducing import duties and registration taxes on electric vehicles as well as importation strategies.

5.6.3 Strategizing and Improving Infrastructure

The government should also look into strategizing and improving infrastructure in Kenya, to reduce the high vehicular traffic and also assist EV markets in providing logistics for EV charging systems. Presently, there are poor road network and obviously limited charging infrastructure to support EV's. Unlike parts of Europe, North America, and Asia, where there is good road infrastructure and public supported and structured in an organized manner, that supports EV's.

5.6.4 Changing Fiscal Regimes and Introducing Incentives

There has to be financing institutions that are willing to invest and support the purchase of electric vehicles. In the case of Kenya, the high investment cost associated with electric vehicles which obviously makes sense in the long term but very challenging in short terms, is a major challenge to the development. Reflecting on the experiences and structures of the "circles" in Kenya, EV industries could tap into the existing structure and work with micro-finance institutions to support the purchase of electric vehicles. However, much government support is still needed in this regard, as MFI's would want to be sure of the uptake potential before investing in the development.

Also, the central business district of Nairobi for example, is characterized by parking fees, which vehicle users pay through an application, and so with the introduction of electric vehicles, it would be feasible for governments to introduce a similar system where these fees would be waived.

Presently, it is not clear if electric vehicles are going to be a pure leasing business where financing institutions invest in electric vehicles and rent them out to private persons or maybe companies, or if it is going to be driven by electric vehicles industries solely.

Governments and policy makers in this region should therefore consider introducing loans, leasing options and other payment schemes that provides much more time to users to pay back the loans. If this is done correctly, through banks and well-structured microfinance systems then it is obvious that, the potential for electric vehicle is huge and the uptake in the market would be very fast.

5.7 Similarities Between Electric Vehicle Transition in Developed and Developing Countries

The similarities put forward are in the context of Kenya, compared to countries like Norway and Sweden. It is important to note that, developed countries (Norway & Sweden) have much longer experience and have reached much higher stages with electric vehicles mobility, whilst developing countries (Kenya) have much lesser experience and at an infant stage in electric vehicle transition. However, these similarities run through the transition of the countries in context.

5.7.1 Range Anxiety

In the early stages of electric vehicle transition, users were anxious about the range of electric vehicles in Sweden and Norway, and the same trend seems to be running through the minds of the general public in Kenya, where currently, charging infrastructure have not been developed much. In the case of Norway and Sweden, charging infrastructure were developed regionally and

expanded nationwide quickly with the support of government as the transition process was rolled out and hence the challenge with range, in one way or the other was resolved.

In doing so, the government of both countries, that is Norway and Sweden invested heavily in road and charging infrastructure to meet the demands of electric vehicle market in the region.

5.8 Differences in Electric Vehicle Transition Between Developed Countries and Developing Countries

The differences put forward are in the context of Kenya, compared to countries such as Norway and Sweden. These are informed by the findings from the study.

5.8.1 Private Sector Driven EV Transition

Considering the business climate in developing countries, with regards to Kenya, I argue that electric vehicles transition would be predominantly driven by the private sector. There is large business to business solutions that are driven by larger corporations, large taxi hauling business, and the public transport systems which is heavily regulated by private individuals-"the circles" and so it is obvious that, these entities would be the driving force behind electric vehicle transition, so far as market is concerned.

In detail, the transition would be driven commercially where the technology and application actually make sense, coupled with small scale infrastructure investment in the early stages that benefits a larger fleet. In that sense, commercial businesses in this region will help build the infrastructure, then government comes in with large well-funded programs to set-up charging infrastructure nationwide. While in developing countries, like Norway and Sweden, it was the government investing heavily in the technology.

5.8.2 Introduction of New Electric Vehicles, Imports of Used Electric Vehicles & Conversion Technologies

It is important to know that, in developed countries, like Norway and Sweden. The electric vehicle transition were characterized by a whole big wave of import of new electric vehicles or buying new electric vehicles from the scratch, and that fits the market created in North America, Europe and parts of Asia. Clearly, customers or users in this region have a stronger purchasing power to acquire electric vehicles as compared to the global south (Kenya).

The electric vehicle industry in Kenya currently relies on the importation of slightly used electric vehicles from Europe, North America and Asia, as well as conversion technologies, where ICE vehicles are locally converted to electric in an attempt to provide fairly good prices for electric vehicles in this region.

In detail, the conversion technologies, where conventional ICE vehicles are converted to electric vehicles have a great potential globally, but in developing countries like Kenya, the conversion technologies have a bigger potential. This is because, they allow individuals and smaller companies to transition towards electric vehicles faster. So instead of people acquiring new electric vehicles completely at a high cost, and considering the poor road infrastructure, the transition would be faster when people actually maintain their vehicles, but only have the technology converted from ICE to electric, which is obviously cheaper in that regard.

5.8.3 Cost Reduction Being the Dominant Landscape Factor Driving Electric Vehicles Transition in Developing Countries (Kenya)

Climate concerns has been the dominant factor so far as electric vehicle transition is concerned in the global north. Nevertheless, the improvement in air quality and environmental conditions remains crucial to policymakers and politicians in the global south.

In practice, Kenya has experienced the effects of climate change in various sectors of its economy, but more importantly, the effects on its transport sector has been significant, as heavy downpours with surface run-offs has damaged a part of its road infrastructure and in turn paralyzed transport services in some parts of the country (Government of Kenya, 2019).

More importantly, the high cost of crude oil and the continuous price fluctuations in crude oil products remains the dominant driving factor so far as landscape factors are concerned. According to NationBeta (2020), the continuous increase in fuel prices in Kenya is as a result of the fluctuations in crude oil prices in the international market as well as the high importation cost.

As a result, crude oil and other petroleum products are costly and hence vehicle users would have to pay higher amounts for fuel, resulting in high transportation costs. It is known that, electric vehicles have proven to save vehicles users up to about 80% of income, and has reduced transportation cost significantly (Interview Respondent, R1).

5.9 MLP Framework Generated to Fit Kenya's Electric Vehicle Transition

The diagram presented below reflects Kenya's electric vehicle transition, through the lens of a crafted MLP. Interestingly, the three analytical levels of the MLP that is sociotechnical landscape, regime and niche levels are maintained. However, the diagram, seeks to differ slightly from Geels MLP framework in the following ways.

The sociotechnical landscape: the social technical landscape represented here, is divided into segments. These segments represent the various forces that are exerting pressure on the sociotechnical regime, in Kenyan context.

Clearly, the dominant landscape force or factor driving electric vehicle transition in Kenya, is high cost of crude oil, and petroleum products. This factor is informed by interviews with key stakeholders. In view of this, high crude oil price or petroleum products has a larger space or region within the crafted MLP framework for this thesis.

In addition, climate change is the second most dominant factor or force driving electric vehicle transition in Kenya. Generally, EVs offer minimum GHG emission as compared to conventional vehicles (Orsi et al., 2016;Wu & Zhang, 2017), and the high dependence of fossil fuel in Kenya's transportation sector is a major contributor to GHG emissions. In relation to this, Kenya has enacted two transformative laws that directly affects its transition to a low-carbon economy; the climate change Act 2016 and Energy Act 2019, of which nationwide electrification of the vehicle fleet has been identified as a priority mitigation action (SIEMENS Stiftung, 2020).

Conversely, climate change is the most dominant factor driving electric vehicle transition in most developed countries, including Norway and Sweden. Although, the effects of climate change, including the recent unprecedented weather conditions, coupled with floods, high temperatures,

energy outages and many more on urban cities like Nairobi are weighty, high crude prices outweighs climate change as a driving force with regards to Kenya's electric vehicle transition.

The least driving forces, yet important in Kenya's electric vehicle transition, are air pollution and clean energy focus. As a result, these factors have the least space or region within the sociotechnical landscape in the crafted MLP framework adopted for this thesis.

In practice, Nairobi's air quality in the past few years has deteriorated significantly, and in turn has propelled key stakeholders and industry players to transition towards electric vehicles mobility.

Due to the severity of the situation, the United Nations Environment Program Office in Nairobi, has liaised with other stakeholders and has prioritized cleaner energy systems to support the sustainable transport options, by electrifying electric motor cycles too, since it constitute a significant proportion of Kenya's transport regime (Government of Kenya, 2019).

Presently, Kenya produces no vehicles. In this regard, Figenbaum (2017) argues that, the absence of vehicle production industries, indicates a weaker ICE regime. That is to say that, Kenya's regime is dominated by vehicle importation firms and stakeholders. Interestingly, the larger size of EVs imported are "second hand" from parts of Europe and North America (Interview Respondent, R1).

Since ICE regimes are crucial for electric vehicle transitions, particularly in countries where there are local production of vehicles, for example Germany and Sweden. The absence of such industries therefore, allows governments and policy makers to consider the impacts of EV incentives on the competitiveness of national automakers as insignificant, while at the same time, more employment opportunities could be seized, if electric vehicles were locally produced, than importing conventional vehicles (Figenbaum, 2017).

The electric vehicle market in Kenya, has not been vigorous in the past years, due to the low government support, in terms of introducing incentives, infrastructure systems and policy frameworks to facilitate EV market. As a result, the dominant regime actors, thus ICE importers, who could have introduced electric vehicles to their business models, have been reluctant, due to the high importation cost, although the Kenyan government has waived off 10% of the excise tax, which is a component of the overall importation duty (Interview Respondents, R1, R2, & R3).

In the case of Norway for example, Figenbaum (2017) argues that, ICE regime auto importers, introduced EV's candidly into their business models, as at when they became available, and in turn, EV's ingested into the ICE regime and markets. However, in the case of Kenya, Interview Respondents R1, R2, & R8 notes that, auto importers have been reluctant in introducing EV's into their business models as a result of the relatively high cost of EVs to conventional vehicles, and the lack of financing options (loans, incentives, etc) to potential buyers.

Clearly, the interaction of the of socio-technical landscape, that is landscape pressure or forces, including high cost of fuel and crude oil products, climate change, air pollution and clean energy focus and socio-technical regime, created cracks in the regime and as a result, niches got established.

In addition, Niche actors in Kenya's EV market, has been dominated by two private companies (See Table 5.9.1.), thus Nopea Ride and Opibus. The country's energy profile, and the speed at which Kenya's economy growing has given rise to niches to breakthrough, although government support in terms of incentives, and a clear cut policy to regulate EVs are absent.

At present, EV fleet in Kenya, is insubstantial, and are only visible in local spaces, that is Nairobi, where charging infrastructure has been put up. This implies that, the nationwide diffusion of EV's

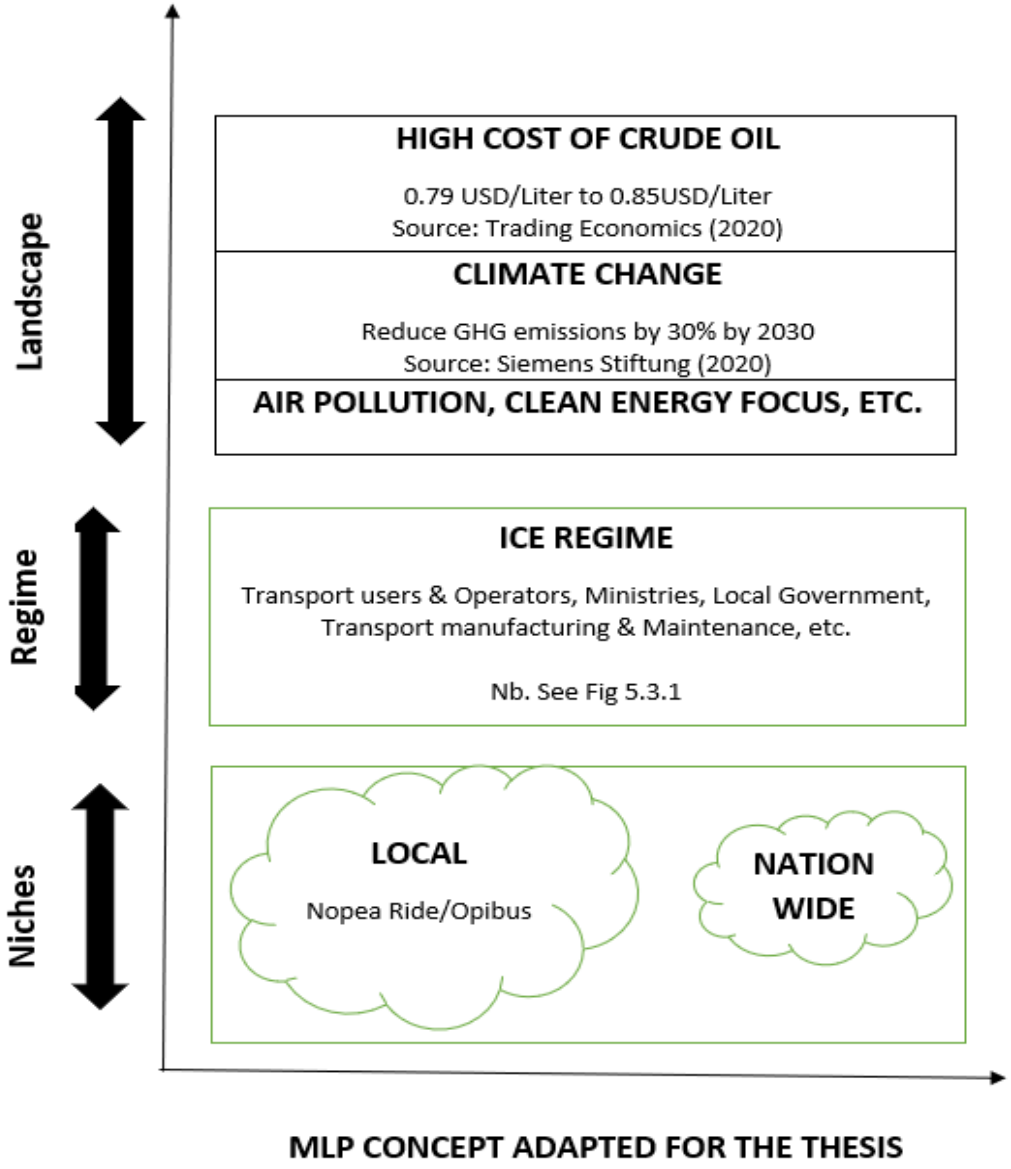
in Kenya have been insignificant, therefore accounting for a very small space as represented in the crafted MLP framework for this thesis.

Table 5. 1: Niche Actors in Kenya's EV Transition

Name of EV Niche	NOPEA RIDE	OPIBUS
Origin	Finland	Sweden
Year Established	2018	2017
Business Model	Sale of second hand EVs	Converts existing ICEs to EVs
Average number of EVs sold/converted per year	8	2
Current number of EVs	40	7

Source: Interview Respondents R1 & R2

Figure 5. 2: Adapted MLP for this thesis (self-constructed)



CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Assessing electric vehicle transition in Kenya, with the MLP framework has been interesting in several ways. Although the framework has been applied significantly in most transition studies across Europe and North America, it has been explored less in developing countries.

The MLP in this regard has proven useful, in providing much details on the interplay between the various analytical levels. In theory, the framework takes almost the same format as applied in most developed countries, but in practice or reality, it differs significantly as it has thrown more light on the dynamics of sociotechnical landscape factors that exerts pressure on regimes and gives way for windows of opportunities to be created.

In terms of regime dynamics, lock-in mechanisms and path dependence has made it difficult for EV transition to be faster in the region. According to Geels et al. (2011), car manufacturers are an important actor in the socio-technical regime, and they exert much influence through their product offerings, marketing strategies and political lobbying. In the case of Kenya, vehicle importers have not been able to fully adapt or introduce new market strategies for EVs, and have not been successful lobbying for EVs. In that regard, Interview Respondent R8 adds that, EVs have not been the center of everyday conversation and politics associated with transport, and this has contributed to sustaining the current regime.

In the case of developing countries, thus Kenya in this context, the MLP provides more guidelines on the dominance of some of the landscape factors over the others. However, this angle of dynamism has not been explored much, considering the application of the MLP in developed countries.

Electric vehicle transition in Kenya, has been driven significantly, by the fluctuations in fuel prices primarily, followed other compelling factors such as climate change, air pollution, clean energy focus and etc, which allowed niche actors to take advantage of this landscape developments.

Although, the electric market is established in Kenya, the absence of incentive packages have led to a delay in weakening the conventional vehicle regime (ICE). Conversely, In the case of Norway and Sweden for example, the introduction of incentives led to a more sudden weakening of the ICE regime and gave rise to a quicker transition nationwide. This dynamism in Kenya's EV transition has been clearly emphasized in the crafted/adopted MLP framework for this thesis, where it depicted a smaller nationwide diffusion of electric vehicles, for which incentives is a major factor in this regard.

In my understanding of Kenya's transition dynamics, the introduction of incentive packages would lead to wider local and nationwide diffusion of EV's which would cause changes in the adopted MLP framework put forward, however, the MLP framework in general, does not prioritize diffusion strategies, wherever it is been applied.

As seen in a number of developed countries, niche markets have the potential to evolve from smaller spatial settings and diffuse to broader spaces, that is nationwide and take up regime positions. In the case of Norway for example, electric vehicles evolved from local spaces and then expanded regionally and then nationwide, with the help of incentives.

However, merging incentives with packages such as toll exemptions, free parking spaces for EV and improving EV infrastructure (road and charging infrastructure) would also be crucial, since vehicle users already pay heavy road tolls within Nairobi.

In summary, Kenya is confronted with a two-way path in its transition. Firstly, to capitalize on OPIBUS's strategy of converting already existing ICE's to EVs, which are cheaper and secondly, to heavily import electric vehicles into the country, as seen with Nopea Ride.

Considering the fact that developing countries are financially unstable, and have the least developed financial systems, governments, policymakers, and mainstream politicians would not want to lose revenue over a long period of time, that is if Kenya prioritizes importation of electric vehicles over conversion of ICE's locally, governments would be compelled to further waive off importation duties, to allow for cheaper EV's which governments would be reluctant to do.

For a faster and successful EV transition, I will suggest that Kenya relies on conversion strategies, rather than the importation of electric vehicles, while producing EV's at fairly good prices and creating job opportunities for its people.

6.2 Recommendation

1. I recommend that, governments need to identify policy gaps (regulatory, fiscal and local) in the current transport policy and invest in policy impact assessments that would fill the policy gaps identified and address the challenges with EV transition in Kenya.
2. There is the need for governments to increase the political support for electric vehicles in Kenya. That is to say that, politicians in Kenya need to highlight EV conversations at the highest level of government and speed up efforts in the introduction/implementation of incentive packages (tax and toll exemptions), addressing infrastructure needs (road and charging infrastructure), standardization strategy, and all relevant policies regarding EV's.

3. There is the need for all relevant EV stakeholders in Kenya to embark on information campaigns to increase awareness as well as visibility regarding EV's and the numerous benefits they present to users.

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APPENDIX

Interview Guide

Name……

Sex……

Position/Occupation…….

1. How long have you lived in Nairobi?
2. Describe the current transportation landscape in Nairobi.
3. Do you own a car? If no, tell me how you travel within the city.
4. How expensive is it to travel or commute within Nairobi?
5. Are there any alternatives aside your usual travel means?
6. Which do you prefer and why?
7. Do you know that electric vehicles are available in Nairobi?
8. What brought about electric vehicles in Kenya? (Explore the MLP landscape factors)
9. Which of the above mentioned factors are dominant and why?
10. Are they cheaper when compared to ICE's?
11. What would make you choose an EV over ICE or vice versa?
12. Do you think there is enough publicity or advertisement about EV's?
13. Who would you define as key stakeholders in Kenya's transportation landscape?
14. What do you think will drive a faster EV transition in Kenya?
15. Per your experience, do you think the local people are ready to switch to electric vehicles? (Explore user preference, habit, culture and etc.)

16. How many EV's do you have currently in operation?
17. how many ICEs do you sell/convert (ICEs) annually?
18. What is the cost and payment plan for EV's?
19. Do you think the government has done enough to push EV's? (Explore policies, strategies, incentives etc.)
20. What role has the public and private sector played in EV transition?
21. What would you say about the current infrastructure and expertise for EV's?
22. What major issue are you confronted with the current roll out of electric vehicles?
23. How do you think the challenges can be addressed if there are any?
24. How do you see the future of EV's in Kenya, let us say 10 years from now?
25. Any form of resistance from incumbents?
26. What role has the media played in the transition process?
27. Are there similarities between EV transitions in developed/developing countries?